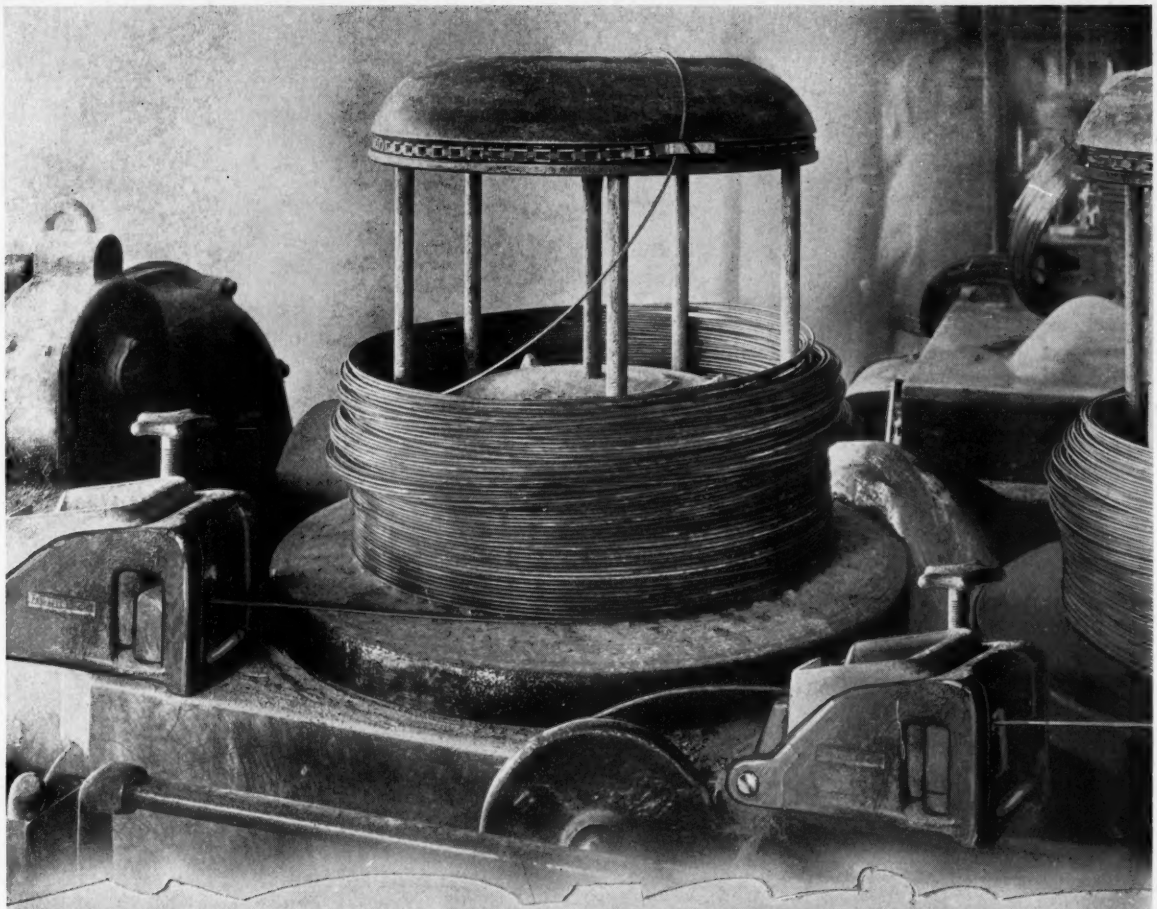
WIRE
& WIRE PRODUCTS



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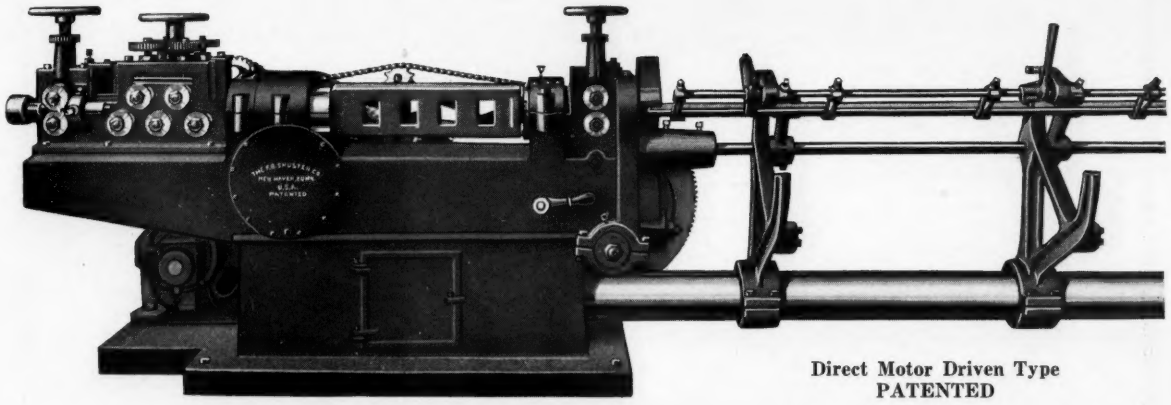

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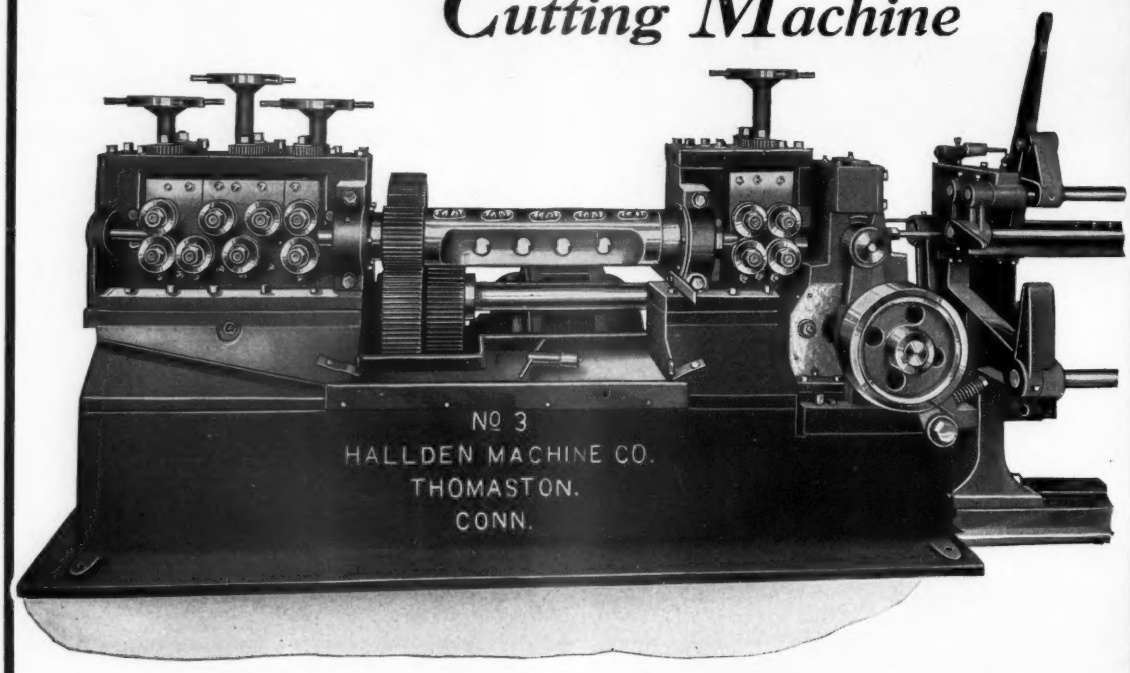

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WIRE & WIRE PRODUCTS

A monthly publication devoted to wire drawing and wire forming

Vol. 5 April 1930 No. 4

Contents

Clarifying the Wire Cable Question ..... R. Woernle 117
Need Shown for Exact Comparisons of Cable Service—Necessity for Durability Experiments—Influence of Groove Base Diameters.

Some Practical Features of Wire Pickling .... Wallace G. Imhoff 120
Basic Principles—Dependence of Pickle Composition on Kind of Wire and Desired Finish—Care Required in Cleaning

Europe Develops Copper-Clad Steel for Cables 122
New Two-fold Material Has Coating That Will Not Peel Off—Methods of Testing Properties.

British Develop Electromagnetic Rope-Testing Apparatus 123
New Equipment Prevents Accidents Due to Internal Flaws.

Should Coarse Wire Sieves Be Calibrated? 124
Description of Various Wire Screens and the Slight Differences in Their Use—Tolerances and Standards.

Influence of Cold Working on Metals ..... F. T. Sisco 125
Plastic and Permanent Deformation—Slip—How and Why the Strength Increases—Slip Planes, Grains.

News of the Industry 126

A Review of Recent Patents 130

New Machinery and Equipment 131

Exports and Imports of Wire and Wire Products 136

Professional and Engineering Directory 144

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Devoted to the Production and Fabrication of Wire

Vol. 5 APRIL, 1930 No. 4

Clarifying the Wire Cable Question

Need Shown for Exact Comparisons of Cable Service—Necessity for Durability Experiments—Influence of Groove Base Diameters

By R. Woernle, Stuttgart *

WIRE cables for industrial uses depend largely upon clarification of the behavior of such cables in elevator and crane service. The results herewith obtained are applicable, even if in a limited manner, to such related fields as railroad cable technique, shaft cables, etc. There are so many unknown factors that the clarification of the problem of wire cables, at least for the present, must be considered insoluble. Because of the difficulty of the task we were inclined towards results that did not agree with actual facts. This behavior led to confusion of the basic subject not to clarification.

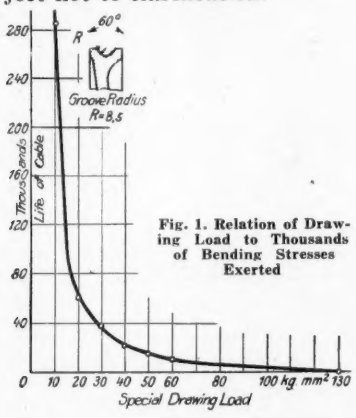
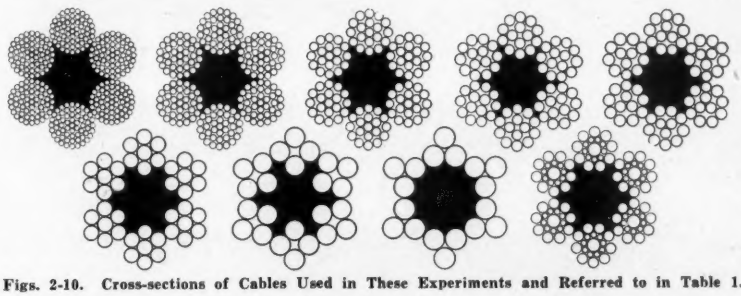


Fig. 1. Relation of Drawing Load to Thousands of Bending Stresses Exerted

Also in putting together cables in practice we cannot reach a definite opinion about the behavior of cable wires because exact means of comparison are often lacking (type of winding, building up of the cable, material used for wires, duration and manner of use, or better the number of working actions (Arbeitspiele) or reversals of stress; and in connection with these, the widely varying limits of load, manner of running of the cables (Seilfahrung), size of rolls, configuration and condition of cable grooves, attention and lubrication.

The duration of cable wires can easily represent an extraordinarily high saving if rest periods and times of inactivity are overlooked, which besides sometimes changes from one cable covering to another, even when the problem is carried out with the greatest care. The life of the cable falls rapidly with an increase of load under otherwise similar conditions.

This important influence, in works with changing load conditions, viz., in elevators and cranes, cannot be expressed in appraisal, or numerical expressions such as strong or moderate, for the manner of use of cables cannot be used in comparison, especially if it is a question of comparing various kinds of works.



Figs. 2-10. Cross-sections of Cables Used in These Experiments and Referred to in Table 1.

*Chairman, V. D. I. Wire Rope Committee. From *Zeitschrift des Vereins Deutcher Ingenieure*. Translated by W. H. Fulweiler, United Gas Improvement Co., Philadelphia.

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408 CONCORD AVE.,
NEW YORK ... N.Y.

No.	Cross Sec. Figs. 2-10	Designation	No. of Strands	No. of wires per strand	Total No. of Wires	Cable Diam. mm.	Diam. of single wires mm.	Cross-Sec. mm²	Tensile Strength Kg/mm²	Method of Winding Cross- kr Direct- L	Winding length of the Strands mm.	Remarks. Some of the cables go to the right and have a fibrous filler. In the cross-wound cables the strands go to the left; in the direct—to the right.
1	c	A 16 DIN 655	6	19	114	16	1.0	89.5	130	Kr	110	blank
2	c	AL 16 DIN 655	6	19	114	16	1.0	89.5	130	L	125	blank
3	c		6	19	114	16	1.0	89.5	80	Kr	110	blank, Built up on A 16 DIN 655
4	c		6	19	114	16	1.0	89.5	80	L	125	blank, Built up on AL 16 DIN 655
5	c	A 16 DIN 655	6	19	114	16	1.0	89.5	160	Kr	110	blank
6	c	AL 16 DIN 655	6	19	114	16	1.0	89.5	160	L	125	blank
7	c	A 16 DIN 655	6	19	114	16	1.0	89.5	180	Kr	110	blank
8	c	A 16 DIN 655	6	19	114	16	1.0	89.5	180	L	125	blank
9	c		6	19	114	16	1.0	89.5	200	Kr	110	blank Built up on A 16 DIN 655
10	c		6	19	114	16	1.0	89.5	200	L	125	blank, Built up on AL 16 DIN 655
11	c	A 16 DIN 655	6	19	114	16	1.0	89.5	130	Kr	110	verzinkt
12	c	AL 16 DIN 655	6	19	114	16	1.0	89.5	130	L	125	verzinkt
13	c		6	19	114	16	1.0	89.5	130	Kr	116	Trulay, blank, Built up on A 16 DIN 655
14	c		6	19	114	16	1.0	89.5	130	L	107	Trulay, blank, Built up on AL 16 DIN 655
15	a		6	61	366	16	0.56	90.1	130	Kr	108	blank
16	a		6	61	366	16	0.56	90.1	130	L	133	blank
17	b		6	37	222	16	0.73	92.9	130	Kr	112	blank
18	b		6	37	222	16	0.73	92.9	130	L	130	blank
19	d		6	14	84	16	1.15	87.2	130	Kr	114	blank
20	d		6	14	84	16	1.15	87.2	130	L	124	blank
21	e		6	12	72	16	1.25	88.4	130	Kr	115	blank
22	e		6	12	72	16	1.25	88.4	130	L	120	blank
23	f		6	7	42	16	1.65	89.8	130	Kr	112	blank
24	f		6	7	42	16	1.65	89.8	130	L	114	blank
25	g		6	4	24	16	2.15	87.1	130	Kr	126	blank
26	g		6	4	24	16	2.15	87.1	130	L	124	blank
27	h		6	3	18	16	2.50	88.4	130	Kr	130	blank
28	h		6	3	18	16	2.50	88.4	130	L	134	blank
29	e		6	12	72	16	1.25	88.4	130	Kr	115	Trulay, blank
30	e		6	12	72	16	1.25	88.4	130	L	117	Trulay, blank
31	f		6	7	42	16	1.65	89.8	130	Kr	115	Trulay, blank
32	f		6	7	42	16	1.65	89.8	130	L	117	Trulay, blank
33	i		6	19	114	16	s.Bem.	92.5	s.Bem.	Kr	98	6× { 1 Dr. with 1.5 mm Dmr. / 9 " " 0.7 " " / 9 " " 1.2 " " } mittl. Festigkeit rd. 120 kg/mm² blank
34	i		6	19	114	16	s.Bem.	92.5	s.Bem.	L	104	6× { 1 Dr. with 1.5 mm Dmr. / 9 " " 0.7 " " / 9 " " 1.2 " " } mittl. Festigkeit rd. 120 kg/mm² blank Trulay
35	c	A 13 DIN 655	6	19	114	13	0.8	57.3	130	Kr	90	blank
36	c		6	19	114	13	0.8	57.3	130	Kr	82	Trulay, blank, Built up on A 13 DIN 655
37	i		6	19	114	13	s.Bem.	54.0	s.Bem.	Kr	80	6× { 1 Dr. with 1.2 mm Dmr. / 9 " " 0.55 " " / 9 " " 0.9 " " } mittl. Festigkeit rd. 120 kg/mm² blank

Accordingly there is seldom found a certain equivalence and therewith a related power of comparison of the durability of crane and elevator cables in practice. It is also to be observed that it is very difficult to say when a cable is in condition to be taken off. Many experiments are needed to show if and when a cable should be unwound. It is especially difficult to estimate the comparative certainty of cables wound in various ways and of various wire counts. This circumstance also makes more difficult the comparison of duration of wire cables in practice.

In cross-wound cables as a result of the more closed cable bands, the broken wires show only a little, or hardly at all, in such manner that a cable with many serious breaks in the wires, still gives the appearance of being trustworthy. The directly wound cables on the contrary, even with comparatively few breaks in the wires, give the impression of danger because the broken wires extend appreciably out of the cable strand. Herein lies, indeed, the advantage of an early warning of the danger of a break, an advantage that the cross-wound

(*Please turn to page 133*)

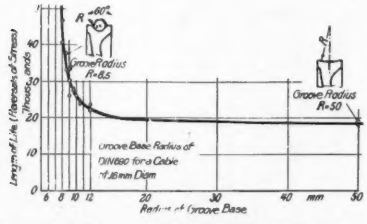

Groove Radius R=8.5
Groove Radius R=50
Groove Base Radius of DIN 680 for a Cable of 16 mm Diam
Length of Life (Reversals of Stress) Thousands
Radius of Groove Base
mm

Fig. 11. Influence of Groove Base Radius on Life of Cross-wound Cable.

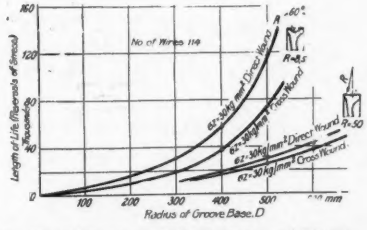


Fig. 12. Influence on Life of Cross- and Direct-wound Cables of 114 Wires.

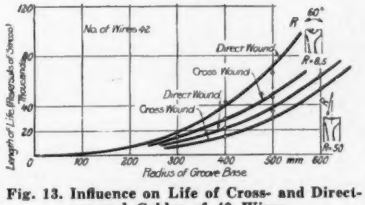


Fig. 13. Influence on Life of Cross- and Direct-wound Cables of 42 Wires.

Some Practical Features of Wire Pickling

Basic Principles—Dependence of Pickle Composition on Kind of Wire and Desired Finish—Care Required in Cleaning

By Wallace G. Imhoff

*President of the Wallace G. Imhoff Co.**

(*Continued from page 95, March Issue*)

IN the group method nine pickling tanks of 800 to 1,000 gal. capacity frequently are employed. Generally the tanks are oval in shape and constructed of wood. The steel rinse tank is for cold running water and the capacity is about twice the capacity of the pickling tanks. The pins hold 8 to 14 coils of wire, or about 2,400 to 3,000 lbs. The coils are raised and lowered by a jib crane. A motor on top rotates the crane through 180 deg. On a horizontal boom there is a cylinder of air or steam with a 6-ft. stroke which raises and lowers the chain. Suspended from the end of the chain is one, two or three hooks. The idea of the three hooks is to give the craneman three chances instead of one to hook into the eyelet or pin. It takes the craneman about 30 min. to make a complete round of changing and emptying the tanks which includes the insertion of nine pins. The tanks are operated 24 to 48 hours before they are emptied.

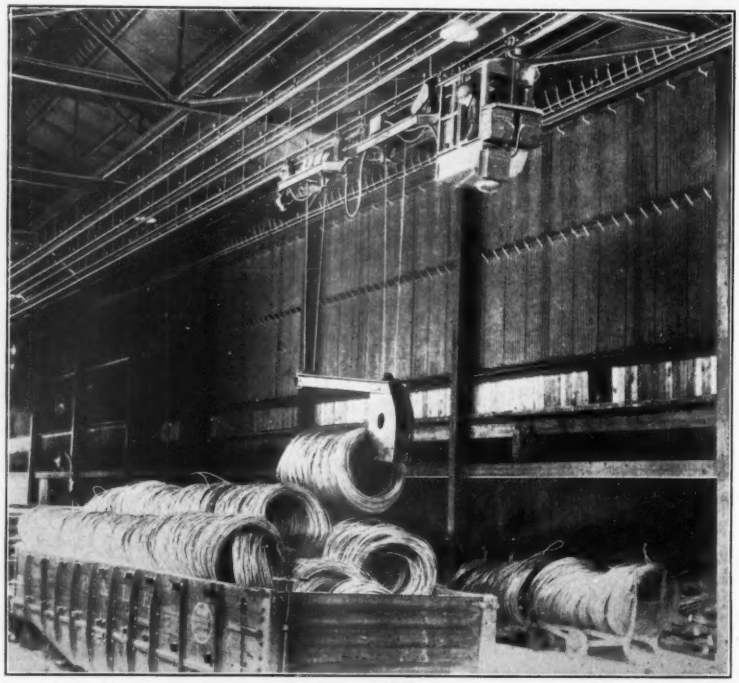


Fig. 4. Modern Overhead Tramrail loading coils of rods in car.
(Courtesy of The Cleveland Crane & Engineering Co.)

It is most important that the rinse should be conducted in a large tank with an excess volume of water, and a continuous flow of water in this tank. The rods should be inspected carefully after rinsing and having passed the inspection are subjected to a water pressure from a pipe, or hose of 90 to 100 lb. per sq. in. pressure. This pressure completely eliminates all film and acid, and any particle which may have adhered to the metal. This water pressure rinse is just as important as good pickling, especially if the rods or wire are to be copper coated.

Pickler Must Know Scales and Oxides

The pickler should know something about the scale and iron oxides to be removed. There are two main kinds of scales and oxides to be pickled. The one is the very hard, brittle, blue to black brittle oxide which forms on the surface of the hot rolled rolls and annealed wire. In addition to this there is the slow forming red rust formed due to standing and exposure to air and moisture before drawing. The heavy dark brittle scale is Fe_3O_4 mainly with perhaps a very small amount of Fe, FeO, and blue Fe_2O_3. The red rust is X Fe_2O_3. Y H_2O or a mixture of iron oxide and hydroxide, Fe_2O_3. $Fe_2(OH)_3$. This is readily soluble in the sulphuric acid pickle if not allowed to stand too long so that the rust burns itself into the steel. The black oxide, Fe_3O_4 is very difficult to remove, as it is not readily soluble in the acid solution.

In the pickling of different kinds of materials the pickling

*Consultants in Zinc Coating (Hot Galvanized) 401 Highland Bldg., Pittsburgh, Pa.

solutions are controlled by the acid strength, the temperature, and the pickling time. It is needless to say that all of these controlling factors should be accurately known, and not guessed at. The picking conditions are greatly affected also by the base metal. Low carbon Bessemer rods will take a weaker acid than low carbon basic open-hearth steel. High carbon rods should be cleaned by a sharp, quick acid.

Another factor which affects the picking conditions is the temperature at which the rods are finished, and the pressures exerted by the rolls. If the rods are finished at a high temperature, a heavier coating of scale forms than when they are finished at lower temperatures, and more acid is required to clean them.

Customary Pickling Solution Temperatures

There is much to be said in regard to the temperature of the pickling solutions. The usual temperature is from 170 to 180 deg. F. but the writer believes more pickle capacity (more tanks) and a lower temperature with a good inhibitor will give a very much higher quality product with much less danger of acid brittleness, and other undesirable features which are known to be caused by higher temperatures.

The pickling conditions should be carefully standardized and controlled, and not carried out by guessing and in a haphazard manner. The tanks should be large, the temperature and flow of steam should be controlled by automatic recording control instruments, and the solutions should be carefully tested from time to time to check the acid strength. There is positively no excuse for guessing and not knowing the proper facts about pickling. With good instruments now available, and quick easy methods of testing the solutions, the only obstacle now needed to be removed is the old time prejudice, which has always stood in the way of progress.

To place pickling operations on the most economical basis and reduce the steel loss to a minimum the bundles of rods should not be left any longer than necessary in the acid. Attention is called to the fact that great damage is done to the steel by allowing it to stand until the red rust has become dry and burned itself into the steel. It is very difficult to pickle off, and in doing so will destroy the smooth skin which is present on fresh steel. Rods should not carelessly be stored where they will become heavily coated with rust.

The importance of proper rinsing has been mentioned. In all pickling operations it is important to wash off the adhered acid and iron salts from the pickle bath. This feature is important, and should be carried out in a thorough manner in order to dislodge any pieces of scale adhering to the surface, and wash off all traces of acid and iron salts.

Types and Styles of Pickling Tanks

The modern method of the design of picking tanks is to have the tanks in a straight line built in units of two to four compartments to the tank. These tanks are constructed of reinforced concrete, lined with double layers of hard burned vitrified common brick, set in improved acid proof cement. The surface of the concrete is covered to the depth of about $\frac{3}{8}$ in. over the inside and outside with a bitumen compound, or high melting point asphalt, which is acid proof and will stand a temperature up to 190 deg. F. The outside of the tank and the floor should also be covered with brick set in the acid proof cement.

The monorail, overhead construction should be electrically operated with the pull chain switch so that the pickling house can be operated with the assistance of a craneman and, so that three laborers and a foreman will operate a large tonnage at a low cost.

It was mentioned before that the most modern and economical method of positive control of the temperature is absolutely necessary. One of the recording temperature control instruments now offered to the steel trade should be installed. It has been proved conclusively that the adoption of one of these instruments is not only foolproof and positive, but is so economical that a machine will pay for itself in the saving of fuel and oil in possibly six months.

Owing to the publicity which has been given to the subject of inhibitors, it needs no special introduction at this point. It is an established fact that a good inhibitor is absolutely essential to produce a clean bright wire, free from acid attack and absolved hydrogen. That inhibitor which is readily soluble in the pickling solution is the most economical, as it is desirable to have the foam on the surface of the pickling bath. An inhibitor which is not quickly or readily soluble will float or remain in the foam, and not pass down into the solution to become effective.

Inhibitors Improve Wire Finish

The properties of inhibitors are well known so that it is only necessary to briefly state that a good inhibitor is very necessary, as it produces a bright white finish on the wire, and prevents hydrogen occlusion into the porus structure of the steel. The effect of an inhibitor is shown very clearly in the drawing of the metal, as the die will draw a larger tonnage if the metal is free from hydrogen, and if the surface of the metal has not been etched, or dissolved by the action of the acid.

The cost of the inhibitor should be figured closely in its effective saving of acid consumption in pounds per ton, against the original cost of the inhibitor per pound, and then due credit should be given to the inhibitor for the saving of metal, and the clean bright surface, and improved quality of the product.

Those rods which are to receive a sull coating are placed

(*Continued on page 137*)

Europe Develops Copper-Clad Steel for Cables

New Two-fold Material Has Coating That Will Not Peel Off—Methods of Testing Properties

A valuable material the applications of which in electrical engineering are not yet widely known is copper-clad steel, an intimate combination of copper and steel. By a special process under which a red-hot steel ingot is covered in such a way with copper (air being excluded meanwhile) that there is complete union between the two metals, local air inclusions and holes being entirely avoided This process ensures that the copper coating will not peel off even when subjected to severe deformation, torsion, or bending. The tensile strength of copper-clad steel is extremely high, amounting to at least 65 kg/mm^2 in the case of wire more than 3 mm. in diameter, and 70 kg/mm^2 for thinner wire, while no appreciable change in tensile strength occurs at temperatures up to 300°C.

As made in Germany copper-clad steel is of two kinds—one with a high steel content and a low copper content and one with a low steel content and a high copper content. The former is principally employed when tensile strength and rust protection are the main factors and the latter when conductivity is the chief property required. The conductivity varies from 20 to 35 per cent of that of copper, according to the thickness of the copper coating and the diameter of the wire. Rusting at the steel core is obviated by the coating. The material is therefore equal to copper from the viewpoint of preventing breakdowns due to corrosion, and is more durable than galvanized steel.

In view of the fact that the section of copper-clad steel is composed mainly of steel and that the two metals are homogeneously welded, its coefficient of heat expansion is very low, approximating to that of steel (about 1.22×10^{-5}). This coefficient varies from 1.24×10^{-5} and and 1.35×10^{-5}, according to whether the copper covering is thin or thick. The specific weight of copper-clad steel is about 8 per cent less than that of copper, which is advantageous for certain applications.

The use of the material for the transmission of a. c. might occasion doubts as to a possible increase in line resistance due to skin effect in consequence of the existence of steel. Tests carried out have shown these fears to be groundless, and that the influence of the skin effect can usually be disregarded. It will thus be seen that copper-clad steel combines the good properties of steel (high tensile strength and elasticity) with those of copper (high conductivity and good resistance at atmospheric influences). Hence it is suitable for numerous applications.

Copper is chiefly used for electricity distribution networks. The use of copper-clad steel cable for this purpose results in several advantages. Owing to its high tensile strength, spans can be made longer, so that the number of masts required is reduced. Moreover, as a result of its low coefficient of heat expansion, the sag of copper-clad steel transmission lines is small, which results in a reduction in the number of breakdowns. Such lines are also very reliable in case of storm, frost, and snow.

With a view to testing the advantages of copper-clad steel cable as compared with copper, a transmission line 3.3 kilometers long was erected in Germany in 1928 of the former material, one of the spans being 234 meters long. It was found that an economy of 15.5 per cent was realized compared with copper, costs being less in all respects—for cables, masts insulators, erection, concrete, and painting, in consequence of the increased average spans (137 meters), as against spans of 114.5 meters if copper had been used.

Copper-clad cable can also be used with advantage owing to its rustlessness in place of the steel wire usually used for supporting suspended lamps in streets and public places. It also represents an ideal material for earthing cables in high-tension systems, lasting as long as copper cable and eliminating the contact resistance resulting from the rusting of steel cable. Though dearer than steel cable, its use represents an economy, as renewal is less frequent, while earthing itself is generally more reliable. On account of its great mechanical strength, adequate conductivity, low contact resistance, and freedom from corrosion it is superior with regard to the last three points to steel cable and with regard to the first point to copper for the purpose of earthing switchgear.

The vast areas now covered by long-distance power stations and the need for a means of communication between the various feeding points, sub-stations, etc., have necessitated the erection of special telephone lines.

Conductivity is less important in this connection, the main requirement being tensile strength, so that copper-clad steel cable is quite suitable for this purpose. The smaller sag of lines made of such material also makes shorter masts possible. Whereas, in addition, with bronze or copper telephone lines there was always the danger of theft, the use of copper-clad cable eliminates this possibility, the union of the metals being so good as to make it too difficult for the copper to be recovered by simple methods. For telephone lines iron or bronze is usually employed and to a smaller extent copper. Iron is cheap but not durable and in certain cases has too low a conductivity. Bronze and copper are more costly, in addition to which copper has but a low tensile strength. Copper-clad steel, however, satisfies all the necessary conditions, and, as it can be used for long spans, erection is facilitated in towns and factory systems where support points are not always easy to find.

The operation of electric railways is attended with considerable difficulty, factors which have to be taken into account being the influence of wind and weather, the strain on the material owing to the frequent starting, changes in speed and braking of the rolling stock, severe shocks and continuous vibration, atmospheric influences, etc. Thus it is clear that the contact-line material needs to be unaffected by moisture, atmospheric influences, smoke, etc., and has to possess high tensile strength and elasticity, a low coefficient of heat expansion, and good electric conductivity. All these requirements are met by copper-clad cable.

It is of great importance that the coefficient of expansion of this material is considerably less than that of copper, so that oscillation will be reduced. It has been found, for example, that the number of breaks of contact lines of copper is greater in summer than in winter. The good properties of copper-clad cable became specially evident in connection with tunnels and subways, where only slight sag is permissible. Its use reduces the number of points of suspension (each of which represents a possible source of breakdown), so that erection is simplified.

British Develop Electromagnetic Rope-Testing Apparatus

New Equipment Prevents Accidents Due to Internal Flaws

THE Applied Science Department of the University of Sheffield has recently carried out, in cooperation with the Carlton Collieries Association and the British Thomson-Houston Company, a most interesting research concerning the development of an electromagnetic apparatus for testing wire ropes. The main purpose for which the apparatus has been developed is to detect internal flaws in colliery winding ropes, although its application is not restricted to this purpose.

The new apparatus can be used for testing wire ropes operating in any service, such as the mooring ropes for airships, the wire ropes for cable tramways, and like purposes. The regulations under the Mines Act in Britain provide that winding ropes in collieries must be taken out of service after 3½ years. This is a precaution to prevent accidents due to internal flaws. Many ropes are thus compulsorily put out of service when they are still capable of a considerably longer life, and, as the cost of a rope may run up to $5,000 or more, there is evidently wide scope for a reliable apparatus for detecting whether a rope is sound or not. A complete electromagnetic rope-testing equipment has been installed at the Hatfield Main Colliery, near Doncaster, Yorkshire.

British Copper Wire Trade In 1929

The principal feature of the Derby smallwares trade during 1929 was the greatly increased business done in electrical wires and cables. The insulation of copper wires by covering with cotton, rayon, silk, enamel, or paper, or any combination of these, is a rapidly increasing business in the Derby district of England. Prominent among the firms that did well in this line are the Macintosh Cable Co., Ltd., the Concordia Electric Wire Co., Ltd., and Derby Cables, Ltd. The first-named is now comfortably installed in a new and up-to-date plant at Derby, and is able to look back on a full production period with complete satisfaction. The last-named is a big new venture which will not be in full production for some time yet, but building is proceeding apace on the new factory site.

Heavy cables and the finer wires were in heavy demand throughout the year, and several important contracts were obtained by Derby firms. Prices are always keen in this market, but Derby factories have certainly been able to more than hold their own. The outlook for 1930 is very bright indeed.

Cable Makers Form Joint Export Organization

At Berlin ten of the leading German cable manufacturing concerns have established an export company to open branches in all principal markets. The company proposes to erect on joint account branch manufacturing plants in countries where high duties prevent imports. A start will be made in the United States and Brazil.

Should Coarse Wire Sieves Be Calibrated?

Description of Various Wire Screens and the Slight Differences in Their Use—Tolerances and Standards

THE appreciable differences in the performance of some sieves of the same nominal mesh, and coarser than the No. 200 sieve, have been brought to attention several times recently both through actual tests and in discussion between interested laboratories. It seems that consideration should be given to the feasibility and desirability of providing some means of calibrating these sieves. Sieves at least as coarse as the No. 20, while complying with the specifications for dimensions of openings, have been found to differ in results of sieving by very appreciable amounts. For example, careful hand tests on well prepared samples of sand, using similar methods for each sieve, gave the indications in Table 1 of three No. 20 sieves, all of which sieves had been found in compliance with specifications.

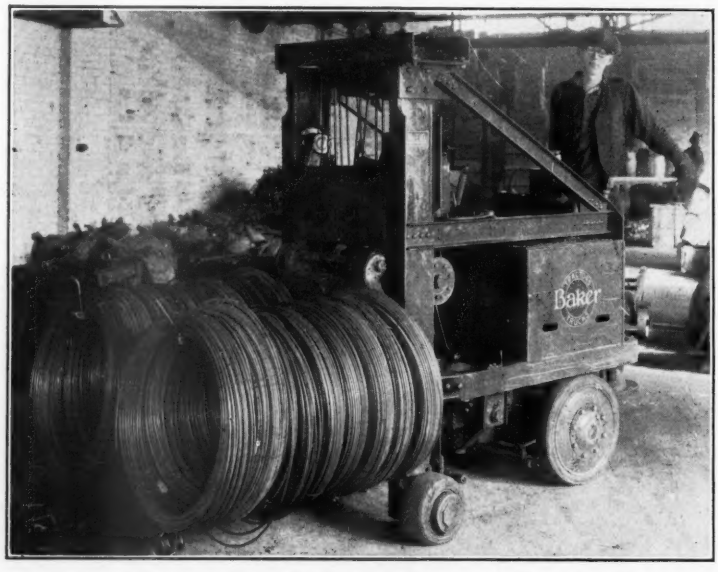
These sieves have been used in other tests, with somewhat similar indications of relative performance. Three No. 30 sieves, when used in careful tests of another sample of sand, gave the indications of Table 2.

Sieve	Percentage retained	Sieve	Percentage retained
A.....	6.3	D.....	3.8
B.....	3.4	E.....	7.3
C.....	2.0	F.....	7.7

A brief study of some other tests indicates that these differences in performance must be characteristic of some of the sieves used in the study of sands and other materials of similar type. There is the possibility that some work may not justify extreme refinement and that the labor of calibration might not be warranted by the benefits resulting therefrom. However, there are some cases where it is desired to obtain more nearly correct values, particularly when making comparisons between various laboratories. This has been found true in foundry research. The abrasive industry, using sieves quite close together in the series of size openings, desires accurate indications of size and gradation of particles.

It has been understood that it is not feasible to make the tolerances for sieve mesh more stringent and, therefore, it would be the practicability of providing standard samples, in somewhat the same manner as supplied for the calibration of the No. 200 sieve when used in testing cement. Such a question would require careful study of possibilities in the preparation of samples, the selection of standards with which to commence the work, the needs of interested industries and laboratories, and particularly whether the samples should be graded over a considerable range in sizes or be restricted to certain narrow zones of sizes, each of which zones might be applicable to certain sieves of materials.

Whatever the solution of the question, and the need of the refinement, it is evident that the careful testing of sieves for compliance with specifications for dimensions of wire and opening may result in a false idea of accuracy of the indications of such sieves so long as there is lacking a means of correcting them with respect to some definite standard of performance.—*Technical News Bulletin,* Bureau of Standards.



Baker Industrial Truck in a wire-drawing mill. This is equipped with two forks for handling two lots of wire coils.

Influence of Cold Working on Metals

Plastic and Permanent Deformation—Slip Bands—How and Why the Strength Increases—Slip Planes, Grains

By F. T. Sisco

Chief of Metallurgical Lab., Air Corps, War Dept., Wright Field, Dayton, O.

(*Continued from page 99, March, 1930 issue*)

DEFORMATION of a substance is change in its external form. Solid substances under stress undergo a deformation of either of two kinds, fluid deformation or plastic deformation. If the wooden staves are removed from a barrel of pitch or tar the contents will, over a period of hours or days, gradually settle down into a large pancake-like mass. The pitch may be so hard and brittle that it is possible to chip pieces off of the cake with a hammer, but, nevertheless, it will gradually settle downward. This sluggish deformation of such amorphous solids as pitch, glass and the like is known as fluid deformation; solid materials such as these are only fluids of high viscosity.

If a piece of copper or iron is put into a tensile machine and stretched it will elongate as much as 25% or more without rupture. This stretching, characteristic of many crystalline metals, is known as plastic deformation and consists of the crystal particles or groups of atoms sliding over each other on planes of weakness known as slip planes. The property of many crystalline metals of undergoing permanent deformation without failure is known as plasticity. Plasticity is a factor in the ductility of a substance. Jeffries and Archer define ductility as the property by virtue of which a substance may be drawn out in tension without rupture. It involves a combination of plasticity and tensile strength, and is generally measured by the percentage of elongation and reduction in area of the tensile test piece.

In the March installment, the author presented his facts on the actual tensile strength increase that comes from drawing wire cold, with actual tables of results. He referred also to the elongation in cold drawing and how the mills handle this, and to the various methods of testing.

Let us view this phenomenon of plastic deformaton a little more closely. If a pure metal such as iron is polished, etched and examined by the microscope the structure will consist of polyhedral grains of ferrite.

Now if the piece is subjected to a load which results in a permanent deformation a series of parallel lines will appear within the individual grains. In general these lines are approximately straight and parallel. When a specimen is deformed but slightly just a few lines are seen; further deformation apparently increases their number. As the piece is stressed still more a new set of lines appears, crossing the first set. These lines within the grains which are caused by stress have been carefully studied by many investigators and have been found to be visible evidence of slip of the particles along crystallographic planes. The lines observable under the microscope are actually steps on the polished surface caused by the raising or lowering of a portion of a grain. If the specimen is now repolished the slip bands disappear. Jeffries and Archer state that a slip band becomes visible under the microscope only after a relatively severe deformation, when the particle has moved approximately 0.00001 in, or about 1,000 atom diameters.

Cold Drawing Stretches the Grains

If a ductile metal such as iron or steel is subjected to a deforming load at or near atmospheric temperature, for example in cold rolling or cold drawing, the grains are stretched out in the direction of working. This elongation due to cold deformation is, as we have seen, due to a series of slips along the crystal planes. This plastic flow occurs within the crystal.

What has happened in order to produce two such different structures in the same piece of steel? The grains are subjected to a high stress in the streamline portion and gradually elongate more and more until what was originally the equiaxed normal grain structure becomes the elongated fibrous grain. The load applied has been sufficient to cause slip along the planes of weakness within the individual grains. Failure occurs along these crystallographic planes, but the fragments do not lose their coherence completely, hence deformation takes place without actual rupture. In other words, under stress a collection of atoms slides along these crystallographic planes, but does not slide far enough so that the bonds holding it to another col-

(*Please turn to page 140*)

NEWS *of the* INDUSTRY

Foreign Trade Opportunities reported by the U. S. Bureau of Foreign and Domestic Commerce during the month of March include inquiries from the following sources: Electrical wire and cable (43911) Paris, France; steel and bronze grills (44011) Toronto, Canada; brass and tobin bronze rods and copper bars (43991) Vancouver, Canada; electrical coil winding machines (44088) Budapest, Hungary; nickel and chromium-resistance round and flat wires (44076) Milan, Italy; bright steel and black bolts nuts and screws (44104) Birmingham, England; barbed wire (44081) Curitiba, Brazil; paraffin and neck greases for steel mills (44019) Glasgow, Scotland; wax coating for wire (44305) Hannover, Germany; automatic barbed wire and wire nail manufacturing machinery (44291) Vancouver, Canada; non-ferrous bars, rods and wire (44254) Rastatt-Baden, Germany; aluminium and brass wire (44354) Hamburg, Germany.

Aluminum Wire Scrap Specifications as adopted by the Aluminum Research Institute at Chicago. Among the specifications for various aluminum scrap materials are new and old wire and cable, as follows:

New Aluminum Wire and Cable: Shall consist of new, clean, dry, unalloyed aluminum wire or cable, free from iron, insulation and any other foreign substance.

Old Aluminum Wire and Cable: Shall consist of old, unalloyed aluminum wire or cable, containing not over 1% free oxide or dirt, and free from iron, insulation and any other foreign substance.

Wire Rod Cartel Gains Members, Increases Quota

The production quota of the Wire Rod Cartel for the first quarter of 1930 has been increased 10,000 tons to 485,000 tons, according to reports received by the Department of Commerce from Paris and Berlin. The decision to increase the quota was made at a meeting in Paris on Jan. 11. The action taken was held to indicate confidence in improvement in export demand for wire rods. The increase in the wire rod quota is considered noteworthy in view of the decision of the International Steel Cartel to continue through February the prevailing 10 per cent reduction in output, which became effective Nov. 1.

Wire rod producers of Czechoslovakia, Austria and Hungary have decided to join the Cartel, although they have for some time adhered to the prices fixed by the international association. Membership is post-dated to Jan. 1, 1930 and will continue until Sept. 30, 1931, when their own three-party cartel expires. The International Wire Rod Cartel will terminate Dec. 31, 1931.

Eighty-five Miles of wire are required to equip with telephone facilities the average New York building of twelve stories.

There Were 74,310,000 Miles of telephone wires in this country on Sept. 30, 6,930,000 more than on the same date last year. Long distance toll service used 10,688,000 miles.

Production Records in '29 Except Wire

New production records were established by the iron and steel industries of the United States in 1929. Practically all principal forms of steel produced in this country registered gains. The only apparent lack of gain was in wire and wire products, the report of the Iron & Steel Div., Dept. of Commerce states. Automobile, railroad and construction industries used more than half the total output, automobiles leading with 18 per cent, railroads coming next with 17 per cent, construction taking 16½ per cent, a total of 51½ per cent to these three groups.

Personal Mention

Benjamin O'Shea, formerly president Union Carbide Co., and Electro Metallurgical Co., units of the Union Carbide & Carbon Corp., New York, N. Y. was elected chairman of the board at a recent directors' meeting. Fred H. Haggerson, former vice-president of the two companies, succeeds Mr. O'Shea as president. F. P. Gormely was elected vice-president and general manager.

—

Carl F. Dietz, former president, Bridgeport Brass Co., and former chairman of the Conn. Mfr's. Ass'n Industrial Relations Committee, has taken over new duties as executive vice president Commander Larrabee Corp., Minneapolis.

—

Joseph V. Santry has been appointed head of Combustion Engineering Corp., to succeed Col. H. D. Savage, who is assisting the receivers. He has served successively as director and vice president in charge of sales for 5 years and as president for 4 years, resigning about 2 years ago.

—

Alden H. Baum, formerly assistant to the president, Mackintosh-Hemphill Co., Pittsburgh has been appointed manager of oil refinery sales of the National Alloy Steel Co., Blawknox, Pa.

—

Edward W. Smith has been elected general manager of

sales of the Pittsburgh Steel Co., Pittsburgh, Pa.

—

D. A. Birdseye, has been appointed Detroit district manager of the recently merged interests of the Lamson & Sessions Co., Cleveland, with offices in the General Motors Building, Detroit.

—

C. H. Jensen has joined the engineering staff of the Copperweld Steel Co., Glassport, Pa. He was formerly with the Pittsburgh branch Byllesby Eng. & Man. Corp.

—

H. V. Blaxter, chairman of the board of the Mackintosh-Hemphill Co., Pittsburgh, and director of the Woodard Machine Co., Wooster, Ohio, has been elected a director of the Union National Bank, Pittsburgh.

—

Josef O. Cadieux has been appointed chief engineer of the Conn. Tel. & Elec. Corp. He became associated with the Conn. company early in its history in production and engineering of telephones, signalling and ignition systems. Many of the exclusive features developed under his supervision. The Conn. Tel. & Elec. Co., Inc., was recently purchased outright by the Conn. Tel. & Elec. Corp. The plant, basic patents and special machinery were acquired outright under the purchase as a unit of the Commercial Instrument Corp.

COMING EVENTS

March 31-April 2. Concrete Reinforcing Steel institute. Sixth annual convention at Bon-Air Vanderbilt hotel, Augusta, Ga. M. A. Beeman, 2112 Tribune Tower, Chicago, is secretary.

April 5-9. Fiftieth Anniversary Celebration, Amer. Society of Mechanical Engineers, in New York and Washington. Calvin W. Rice, secretary, 29 West 39th St., New York.

April 7-12. Annual convention and exposition, Amer. Oil Burner Assn., Hotel Stevens, Chicago. Harry F. Tapp, executive secretary, 342 Madison Ave., New York.

April 22-23. National Machine Tool Builders' association. General cost conference at Hotel Cleveland, Cleveland. E. F. DuBrul, 1415 Enquirer building, Cincinnati, is general manager.

April 23-25. American Welding society. Annual meeting to be held at Engineering Societies building, New York. Miss M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary.

May 1-3. American Gear Manufacturers association. Annual meeting at Hotel Gibson, Cincinnati. T. W. Owen, 3608 Euclid avenue, Cleveland, is secretary.

May 12-17. American Foundrymen's association. Annual convention at Public Auditorium, Cleveland. C. E. Hoyt, 222 West Adams street, Chicago, is secretary.

May 29-31—57th Annual Meeting of the American Electrochemical Society at St. Louis, Mo.

June 9-12. Semi-annual meeting of the American Society of Mechanical Engineers at Hotel Book-Cadillac, Detroit, Mich. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

June 16-20. Exposition sponsored by Assn. of Iron & Steel Elec. Engineers at Broadway Auditorium. Buffalo, N. Y. John F. Kelly, man. director, 1010 Empire Bldg., Pittsburgh, Pa.

Brief Trade Notes

Newton Steel Co., as of Sept. 30, 1929, shows total assets of $13,002,923, compared with $10,175,827 on Dec. 31, 1928, and surplus of $4,002,079, compared with $2,681,760. Current assets were given as $5,143,744 and current liabilities as $968,523 on Sept. 30, 1929, compared with $5,749,931 and $1,515,963, respectively, on Dec. 31, 1928.

Philadelphia Electric Co., Ninth and Sansom Sts., Philadelphia, is arranging an expansion and improvement program to cost $26,400,000, including additional power facilities, construction of steel tower transmission lines, power switching and substations, etc. Company engineering department will be in charge.

Ohio Bolt & Nut Co., Berea, Ohio, has awarded general contract to Gilchrist Construction Co., Western Reserve Bldg., Cleveland, for one-story addition, 45x160 ft., to cost about $45,000 with equipment. John W. Bagley, 1706 Euclid Ave., Cleveland, is architect.

Vail Mfg. Co., 1752 East Seventy-fifth St., Chicago, manufacturer of thumb tacks, paper clips and other wire specialties, has plans for a three-story addition, to cost over $70,000 with equipment. L. E. Russell, 140 South Dearborn St., is architect.

Riverside Metal Co., Riverside, N. J., manufacturer of fine sheet wire and rod specialties, bronze products, etc., has begun construction of addition, totalling about 60,000 sq. ft., to cost about $300,000 with equipment. Company is affiliated with Keystone Watch Case Co., with factory on adjoining site.

Witherow Die Rolling Corp., Neville Island, Pittsburgh, recently organized by Lawrence D. Blair, 5618 Northumberland St., and associates, contemplates operation of local plant in Neville Island district for manufacture of iron and steel products. James M. Bovard, University Club, is treasurer.

Union Wire Die Corp., 333 West Fifty-second St., New York, has leased space in Century Bldg., Pittsburgh, for new branch plant, to cost $60,000.

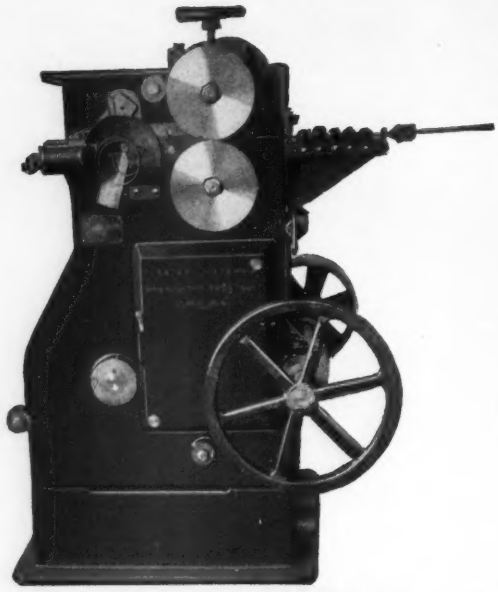
American Steel Company, Pittsburgh, has succeeded the Pennsylvania Corp., and the Ellwood City plant of the latter has been disposed of and dismantled. The American company is operating the American Cotter Pin Co., in Ellwood City making flat and shaped wire.

Scovill Mfg. Co., annual report shows a substantial improvement in the business of the company and its subsidiaries. A gain in surplus of $265,258 and a gain in assets of $462,383 in 1929 and an increase in dividend distribution of almost a million over 1928, are the outstanding items shown in the balance sheet. The accounts payable were also $360,000 less than a year ago.

Sleeper & Hartley TRADEMARK

Designed for the Uph

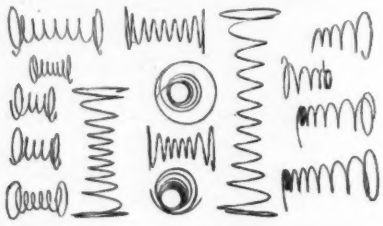
THE MACHINES THAT PU



The Improved Furniture Spring Coiling Machine

is capable of turning out any of the standard furniture springs. Recently re-designed, the machine has now a clutch in the feed wire driving mechanism. This does away with the old fault found in other machines which open the feed rolls during the cutting operation. The new clutch, designed by us, is easy to adjust and maintain, and will deliver a maximum of power.

Below are shown a few of the spring form variations produced.



The machine takes from No. 8 (.162) to No. 14 (.080) wire, feeding from 27½ to 118½ inches of wire per spring as desired, at a rate of from 30 to 50 springs per minute.

The Marshall Spring Coili

produces the spring forms, shown above, which the furniture, cushion and mattress manufacturers change from the time-honored furniture spring to spring of lighter wire has been met by this keep turns out 50 of these fine cushion, mattress and up

With a feed controlled by change gears, varied easily adjusted cams. Wire from No. 14 (.08) to any length from 16 to 54 inches.

The Marshall Spring Coiling Machin

is shown here with the per-driven reel supplied with ach machine. This reel, Sleep & Hartley designed, is provided ith a triple-cone pulley which aws for any ordinary reel speed.

American Agents

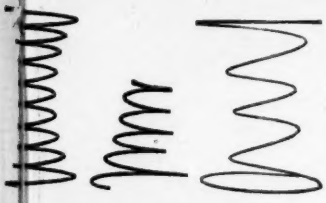
NEW YORK TERRITORY—Triplex Machine Tool Co.
PHILADELPHIA TERRITORY—Swind Machinery Co.
CHICAGO TERRITORY—Neff, Kohlbusch & Bissell, Inc.
SAN FRANCISCO—L. G. Henes Machine Tool Division of Jenison Machinery Co.
LOS ANGELES—L. G. Henes Machinery Co.

SLEEPER & H

WORCESTER, M

pholstery Spring Maker

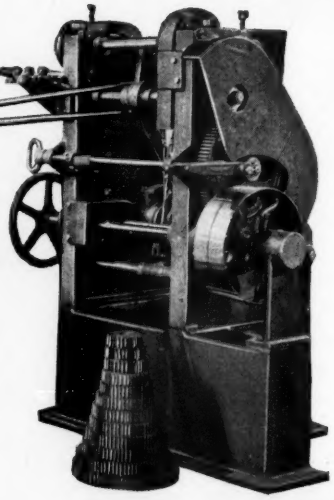
UT THE "RINGS" IN SPRINGS



g Coiling Machine

ve, which are in such demand among nufacturers at the present time. This e spring to the more resilient Marshall this Sleeper & Hartley machine which ess ad upholstery springs per minute.

ears, tried forms are obtained through 4 (.0) to No. 18 (.047) is handled in



Spring ain

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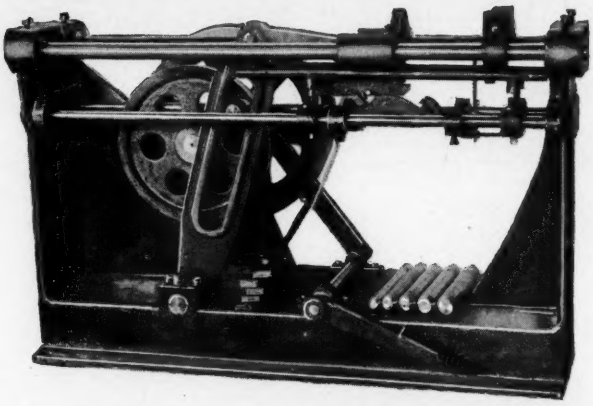


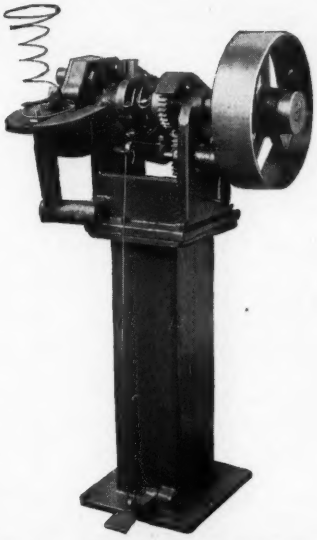
This Furniture Spring Setting Machine

is designed especially for a particularly difficult type of work. Constructed with an eye to simplicity and ease of operation, it is found that the average workman can set from 30 to 35 springs a minute.

It will handle single or double-cone springs with equal ease, and strip them from the arbors, thereby eliminating a hand operation. The machine is clutch-controlled and will handle springs from 3 to 6½ inches in diameter to the large ends.

The Upholstery Spring Knotting Machine

shown at the right, has recently been developed to handle any of the Furniture or Marshall springs used in the upholstery trades. It has a range, according to construction, of springs from 2½ to 6½ inches in diameter at the large ends. Sturdily constructed, the machine is capable of high speed production.



HARTLEY, INC.

MASS., U. S. A.

Foreign Agents

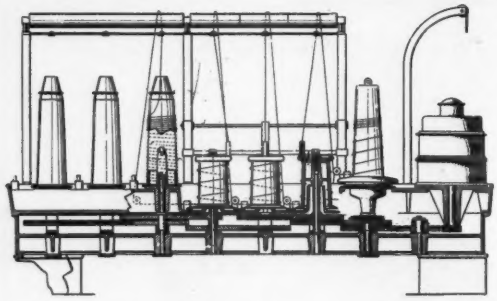
UNITED KINGDOM—Mr. Fredk. A. Perry, 63 Queen Victoria St., London, E. C. 4

MONTREAL AND TORONTO—Arthur Jackson Machine Tool Co.

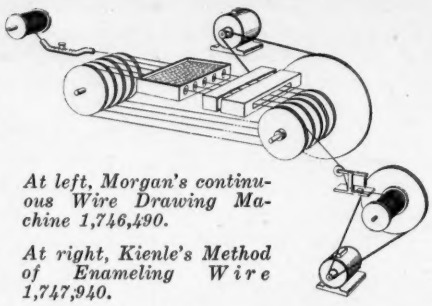
AUSTRALIA AND NEW ZEALAND—Edwin Wood Pty. Ltd., Melbourne

JAPAN—Andrews & George Co., Tokyo

A REVIEW *of* RECENT PATENTS



Complete descriptions and drawings of the patents referred to may be had for twenty five cents. Address Wire & Wire Products, 551 5th Avenue, N. Y. C.



At left, Morgan's continuous Wire Drawing Machine 1,746,490.

At right, Kienle's Method of Enameling Wire 1,747,940.

No. 1,746,490, CONTINUOUS WIRE DRAWING MACHINE. Patented Feb. 11, 1930, by Ralph L. Morgan, Worcester, Mass. An object of the invention is the provision of a friction delivery device for a drawing block so constructed that it may be conveniently operated manually, after the threading of the blocks, to accumulate a desired wire storage upon each block. The delivery device thereafter automatically delivers the wire required for the next succeeding die and block and compensates for any variation in the draft between the two blocks.

No. 1,745,680, CONTINUOUSLY LOADED TELEPHONE OR TELEGRAPH CABLE. Patented Feb. 4, 1930, by Archie R. Kemp, of Westwood, N. J., assignor to Bell Telephone Laboratories, Inc., New York, N. Y., a corporation of N. Y. The main objects of the present invention are: to provide an insulated continuously loaded conductor or cable which is efficient and is adapted for high frequency wave transmission, and in which the loaded conducting wire core is effectively protected against the influence of external mechanical forces, the protection being effective over an indefinite number of years; and to provide for a method of equalizing strains in the loaded conducting core caused by external forces or pressures, whereby manufacturing is simplified and cost reduced.

No. 1,747,272, METALLIC FABRIC AND METHOD OF FORMING SEAMS THEREIN. Patented Feb. 18, 1930, by Nelson W. Webb, Belleville, N. J., assignor to Eastwood Wire Mfg. Co., Belleville, N. J., a Corporation of N. J. The principal object of this invention is to provide a method of forming a seam between the ends of the fabric. To this end the patentee places in the edge of the fabric to be joined a thread previously covered with or encased in solder. Such a solder-covered wire may be formed by encasing the wire in a tubular covering of solder and drawing the solder-covered wire to size. This leaves a very thin uniform layer of solder over the entire surface of the wire. By heating the wire so as to melt the solder, a suitable flux having been applied thereto, the wire becomes secured to the intersecting wires by an intimate metallic union.

No. 1,747,273, WOVEN WIRE CLOTH AND METHOD OF FORMING SEAMS THEREIN. Patented Feb. 18, 1930, by Nelson W. Webb, Belleville, N. J., assignor to Eastwood Wire Mfg. Co., Belleville, N. J., a Corporation of N. J. This, as well as the above and the following three inventions relate to woven wire cloth for paper making machines, and this particular invention has for its object the provision of a seam whereby deformations in the wire fabric is prevented. The wires about which the lacing passes are secured to the intersecting wires, and the lacing wire is also secured to the wires.

No. 1,747,274, WOVEN WIRE BELT FOR PAPER MAKING MACHINES AND METHOD OF FORMING THE SAME. Patented Feb. 18, 1930, by Nelson W. Webb, Belleville, N. J., assignor to Eastwood Wire Corp., Belleville, N. J., a Corporation of N. J. According to the present embodiment of the invention the end weft wires are of slightly greater cross-sectional width than the diameter of the wires of which the cloth is woven, and are slightly less in thickness than the diameter.

No. 1,747,275, WOVEN WIRE BELT FOR PAPER MAKING MACHINES. Patented Feb. 18, 1930, by Nelson W. Webb, Belleville, N. J., assignor to Eastwood Wire Corp., Belleville, N. J., a Corporation of N. J. In this invention, the end weft wires are of oval cross-section and in connection with the warp wire and provide a structure which will be self-brazing upon the application of heat.

No. 1,747,276, WOVEN WIRE BELT FOR PAPER MAKING MACHINES. Patented Feb. 18, 1930, by Nelson W. Webb, Belleville, N. J., assignor to Eastwood Wire Corp., Belleville, N. J., a Corporation of N. J. According to the present embodiment of the invention the end weft wires are of ribbon-like cross-section and preferably are of slightly greater cross-section width than the diameter of the wires of which the cloth is woven, and are slightly less in thickness than diameter of such wires.

No. 1,747,631, WOVEN WIRE SCREEN. Patented Feb. 18, 1930, by August E. Helman, Cleveland, O., assignor to The W. S. Tyler Co., Cleveland, O., a Corporation of Ohio. Comprising longitudinal and transverse wires, this woven wire screen contains one series of wires with equidistantly spaced hardened knuckle portions, the knuckle portions having flat surfaces adapted to receive and engage therein the wires of the other series in a locked and regular relation, and with sufficient inherent resilient pressure to maintain the same in their predetermined relationship and to prevent sleaziness.

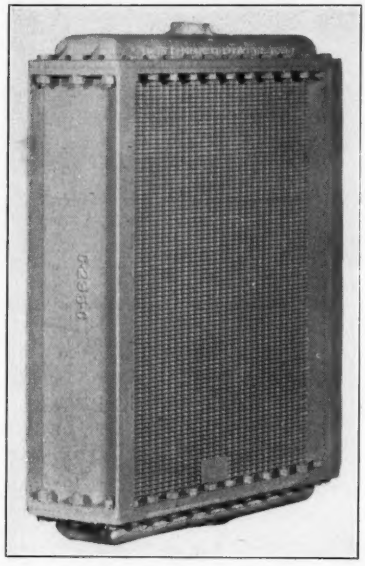
No. 1,747,812, WIRE SPLICING TOOL. Patented Feb. 18, 1930, by Henry G. Barsch, Stonewall, Tex. The frame member of this wire splicing tool is so made as to permit connection of the wires thereto, stretching of the wires, and subsequent twisting of the connecting wire, in order to effect a dependable connection between previously broken ends.

No. 1,747,940, METHOD OF ENAMELING WIRE. Patented Feb. 18, 1930, by Roy H. Kienle, Schenectady, N. Y., assignor to General Electric Co., a Corporation of N. Y. The method outlined in this patent, for enameling bare wire, consists in drawing the wire at a high speed through a bath of enamel and then through a wiper provided with an outer orifice having a square edge.

Young Coolers for Quenching Oil

In order that quenching baths may be uniformly effective, they must be maintained at a substantially constant temperature. If a quenching tank is used in anywhere near capacity, the oil in it has to absorb a large amount of heat, since the steel parts are lowered or dumped into it while red hot. Oil has only about half the heat capacity as water, and the oil temperature rises quickly, hence energetic cooling means must be provided.

In the past it has been customary to place cooling pipes or coils at the bottom of the tank,



Young Cooler, as Used in Wire Mills for Keeping Quenching Oil at a Constant Temperature.

through which cold water was circulated, but it has been found to be a more practical plan to let the oil flow or trickle over automobile-type radiators through which cold water is flowing. The Badger Mfg. Co., of Milwaukee, Wis., manufacturers of automobile bumpers, employ a quenching tank holding 50 bbl. of oil and cool this oil with a battery of 20 coolers of a type manufactured by the Young Radiator Co., Racine, Wis. There is a similar installation at the plant of the Harvey Spring & Forging Co., Racine, Wis. A five-bank two-row type of cooler for quenching installation is utilized by them.

In the installation referred to, about a ton of steel is passed through the quenching tank per hour, being discharged into it while red-hot, but the temperature of the oil is kept at 135 deg. F. The oil is pumped from the tank into the cooling unit located in the open air, being discharged into a perforated tray at the top and dripping from one of the five superimposed radiators to the next, finally collecting in a drip pan at the bottom, from which it returns to the quenching tank by gravity. Cold water enters the series of five radiators at the bottom and leaves the top, being discharged into the sewer. The temperature of the oil in the quenching tank can be controlled within moderate limits by varying the rate of flow of the cooling water.

The units, one of which is shown herewith, are made of copper, tubular cores with heavy cast iron sides and tanks, and cores are brazed into the tanks making a very strong construction and allowing for a large volume of water to give greater cooling circulation. The fins are of the self-cleaning type, through which the oil passes; this eliminates clogging and flushing. Many of these units have been installed in wire products plants.

Large Drive Gear for Rolling Mill

Recently, the Nuttall Works of the Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa., completed a double-reduction gear unit for driving rolls in a steel mill at Leechburg, Pa. The unit transmits power from a 1,600 h. p. motor running at 705 r. p. m., through two sets of gears having a ratio of 14 to 1. For the first reduction two sets of helical gears are used. These are mounted one at each end of the high and intermediate speed shafts. Between the helical gears on the intermediate shaft

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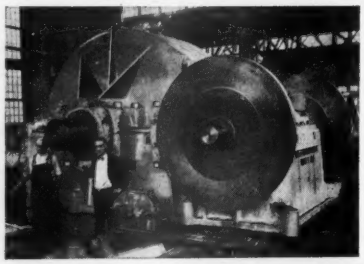
is the pinion which drives the slow herringbone gear. Sleeve bearings are used throughout. All rotating parts are lubricated by a splash system. This unit is capable of developing more than 2,000,000 inch-pounds



Side view of 1,600 h. p. Double Reduction Unit. The Small Unit Is Also a Double-reduction for Use with a Motor of 10 h. p.

of torque at the low speed shaft. Total weight including flywheels is 40 tons.

Three other units of single-reduction type were built for the same mill. These were each for use with 800 h. p. motors running 275 and 688 r. p. m. Ratios of these units are 1.83 to 1, 2.5 to 1 and 3.67 to 1.

Tungsten Electric Corp., a subsidiary of Eisler Electric Corp., 730 S. Thirteenth St., Newark, N. J., manufacturer of tungsten products has plans for establishment of plant in Europe. Dr. Clemens Laise, president, has left for trip abroad to select site and arrange details. Initial work will cost $150,000. Charles Eisler is head of parent organization.

L. Norris Hall, Inc., 940 North Front Street, Philadelphia, iron and steel products, wire goods, etc., has leased part of building at Locust and Twenty-fifth Streets, for branch storage and distributing plant.

Liberty Wire Works, Inc., Buffalo, care of Herbert L. Wechter, 179 Timon Street, recently organized, is planning operation of local plant to manufacture wire goods. Joseph H. Schmitz, 361 Pratt Street, is an incorporator of new company.

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Clarifying the Wire Cable Question

(*Continued from page 119*)

cables do not show in a similar manner. But one would be inclined, accordingly, to replace the directly wound cable comparatively sooner.

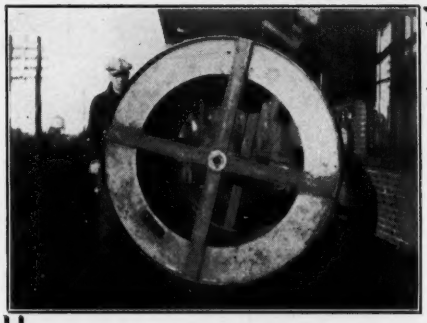
In contrast to the results in practice, the duration experiment is able to predict with comparative speed and certainty the saving of the cable that is to be expected, because hereby the comparison is made certain. The durability under otherwise similar conditions, leads to a single comprehensive value of comparison, to a value of limit, namely to the bend count to the break, that is to the duration of life.

Experimental Program

A study was made of the radius of the base of the groove the manner of winding, the load of the cable, the thickness of wire, the strength of the wire upon the life of elevator and crane cables. Also the cable tension in practice was measured. Further, in considering the point of time of discarding cables, a study was made of the important influence of the number of reversals of stress upon the decrease of carrying power of the cable and the relation between the number of breaks of the wires in 1 meter length of cable, and the decrease in carrying power.

The comparison of length of life of nominally similar wire cables, which was made under similar conditions, shows how, under planned experiments with long life may be obtained. Further, notes are made on the influence of galvanizing, the adjustment of cable wires and of the influence of contra ("B") bending upon the length of life of cables. Finally the material of the wires was analyzed, in order to find the relationship between the chemical composition of the wire and the behavior of the cable. Also samples of wires, "Dornbent," unwound, and torn were studied.

Now it is to be expected that in the difficult and tedious field



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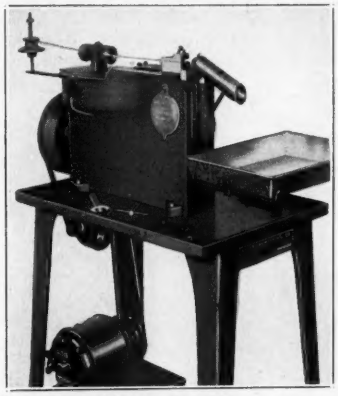

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of the study of wire cables, practice would gradually give the basic working plans and means of comparison which are so urgently needed.

Even though the experiments, because of the wide field, could not be brought during the first year to such a conclusion that on the findings the consideration of elevator and crane cables can be based, nevertheless, the Committee of the Society of German Engineers for the study of cables expressed the hope that the results which I spoke of having obtained up to that time should be made public as soon as possible, because the partial results would make clear

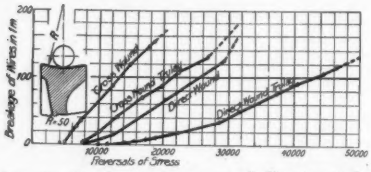

Fig. 14. Breakage of cross- and direct-wound also Trulay wires.

a certain field of action and would give direction to the expert for the starting point in a survey of cables.

Experimental Methods

With the machine for testing the duration of cables it was possible to use a load up to 5,000 kg. with pulley diameters of from 300 to 1,200 mm. The machine was selected so that cables as used in practice could be tested. It is suitable for testing cables with diameters up to 26 mm. The cast iron pulleys are patterned after the drive and span pulleys and may therefore be interchanged in a convenient manner. The threefold arrangement of the experimental pulleys enables the carrying out of durability tests with bending of the cables in the same manner (crooked-straight-crooked) or with centre-bending, "S" bending (crooked-straight-contra-crooked). In the three fold arrangement of the pulleys, the cable is bent in several sections, so that an appreciable length of cable is tested. The cable lift produced by a swinging winch can be altered.

The time of action of the machine can be regulated between 22 and 44 in one minute.

See Table 1 for experimental cables, Figs. 2-10 for cross sections.

The loads were chosen relatively high in order to perceive the conformity of law as soon as possible. In further durability experiments it was possible to limit this idea to the essential in practice, which seems necessary in consideration of the long time which is to be expected with the usual load of work.

For further experiments still other technically important profile forms are provided, besides the influence is studied of the material of the pulleys, viz., steel, cast steel, bronze, etc.

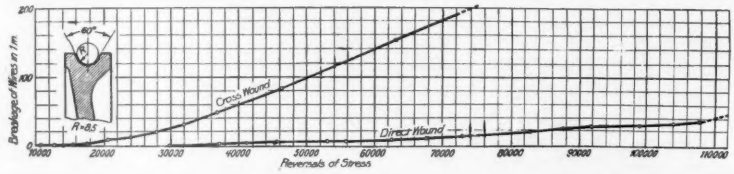

Fig. 15. Rise of disturbance in cables, both cross- and direct-wound of 114 wires.

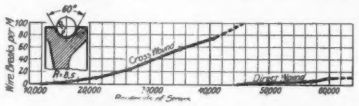

Fig. 16. Breakage of cables with 42 wires

Consideration of the Diameter of the Groove Base: Influence of the Method of Winding.

In Figs. 12 and 13, which show the influence of the manner of winding on the life of the cable, depending upon the diameter of the pulley in a specific load of Oz=30 kg/mm. we see the superiority of direct winding over cross winding. In Fig. 12, a cross wound cable A 16, DIN 655 (114 wires) is compared with the corresponding direct wound cable A. L. 16 DIN 655 both having a tensile strength of 130 kg/mm. Figure 13 contains the comparison of cables with 42 wires with 16 mm. diameter and 130 kg/mm. tensile strength with direct and cross wind. The experiments were made on pulleys with groove base radius of 8.5 and 50 mm.

The duration of life of the cables of both methods of winding tends to become equal, as is to be expected, at 50 mm. groove base radius, but the superiority of the direct-wound cable (which for practice seems important) is not hereby lost, notwithstanding the influence of the high pressure between the cable and pulley tending to wipe out the advantage of direct winding.

Figures 14-17 make clear for the above mentioned wire counts of 114 and 42, the slower rise of disturbances in direct-wound cables (breaking of wires in 1 m. length of cable in consideration of the number of reversals of stress) in contrast to the cross-wound cable, at a disc diameter of 500 mm. and groove base radius of 8.5 and 50 mm.

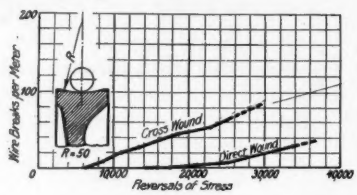

Fig. 17. Rise of disturbance in cables, both cross- and direct-wound, of 42 wires.

A cross cable A 16 DIN 655 with 130 kg/mm. tensile strength was investigated with a spec. load of 30 kg/mm. on a pulley of 400 mm. diameter. Figure 13 shows that with increasing groove base radius, the length of life quickly decreases as a result of the increase of spec. pressure between cable and pulley, and that with a groove radius of 50 mm., i. e., at the cylindrical running surface of the pulley used in practice, the life sinks to about one half as against sufficient support of the cable in the groove. At 12 mm. radius (DIN 890) permitted for profiles of cable pulleys for one cable of 16 mm. diameter, we can determine an appreciable decrease in life.

(To be continued in May)

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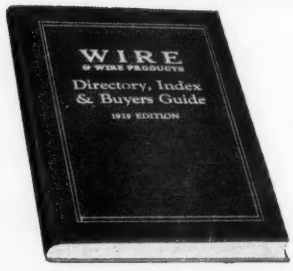

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Domestic Exports and Imports of Wire and Wire Products

Exports of iron and steel wire and wire products from the United States in December, 1929 and January, 1930
(In gross tons)

Item	December 1929	January 1930	January 1929
Wire rods	3,056	3,481	4,411
Plain wire	3,275	2,891	3,845
Barbed wire and woven wire fencing	4,397	2,414	6,529
Wire cloth and screening	113	187	152
Wire rope	375	412	620
Insulated wire and cable	63	44	163
Other wire and manufactures	630	888	926
Wire nails	806	517	1,498
Nails other than wire	587	591	836
Tacks	55	43	58
Bolt, nuts, rivets, except track	1,479	1,122	1,411

Imports

Imports of iron and steel wire and wire products into the United States
(In gross tons)

Item	December 1929	January 1930	January 1929
Wire rods	1,039	944	1,183
Barbed wire	544	377	285
Round iron and steel wire	476	447	602
Steel telegraph and telephone wire			
Flat wire and strip steel	154	209	149
Wire rope and strand	222	297	133
Other wire	63	55	41
Nails, tacks and staples	740	595	708
Bolts, nuts, rivets and washers	74	26	18

EXPORTS for the month of January, at least in iron and steel products, took a decided upward turn, total shipments amounting to 225,090 gross tons a gain of nearly 10,000 tons. In the wire specialties, wire rods showed the heaviest tonnage although this was approximately 1,000 tons under January of last year. Practically the same statement applies to plain wire and barbed wire.

Imports show a number of decreases over December but a few increases over January of last year. The largest total consisted of wire rods 944 tons as compared with the 1,183 in January, 1929. The second largest was not as would be expected, barbed or round wire, but included nails, tacks and staples taken as a group, with tonnage of 595. Other figures will be noted in the tables given above.

Driver-Harris Co., manufacturer of wire specialties and special alloys, reports for the year ended Dec. 31, 1929, net profit of $953,507 after charges, Federal taxes and a deduction of $84,759 for nonrecurring depreciation, equivalent after 7 per cent preferred dividends to $9.59 a share, par $10, on 91,220 shares of common stock outstanding after the recent ten for one split. This compares with $273,816, or $2.10 a share, on above number of shares in 1928.

American Chain Co., Inc., and subsidiaries report for the year ended Dec. 31, 1929, net income after depreciation, amortization, interest and Federal taxes, and including $274,766 extraordinary nonrecurring income, of $3,279,341, the largest in the company's history. This is equivalent after 7 per cent preferred dividends to $10.12 a share on 250,033 shares of no par common stock.

James W. Schofield, formerly of the Los Angeles office of the Columbia Steel Corporation, has become associated with the American Rolling Mill Co., of California, San Francisco. He had previously been identified with the Pacific Sheet Steel Co. and the Pittsburgh Crucible Steel Co.

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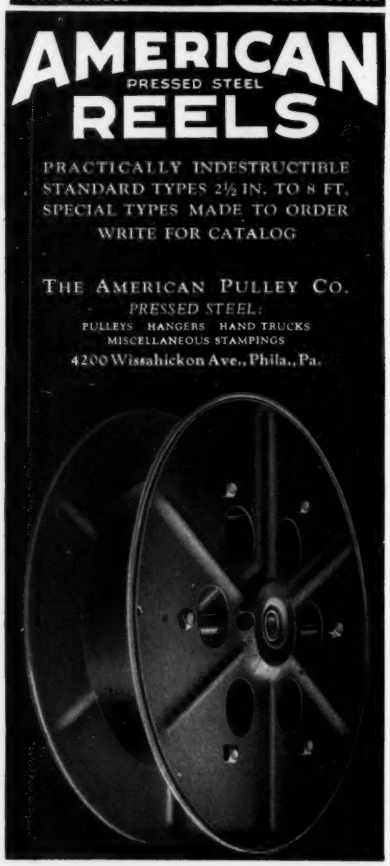

Practical Features of Wire Pickling

(*Continued from page 121*)

on a sulling rack where the coils are kept moist by means of fine sprays of water. The surface of the steel soon becomes coated with a brownish, or greenish rust called sull, or water-rust, due to the action of the water, the traces of acid left on the wire, and the oxidation due to the exposure to the oxygen of the air. Wire which is to receive a bright finish cannot be treated in this manner however, as the sull, or water-rust tends to darken the color of the wire when drawn.

If the wire is to be copper coated the pin is lowered into a cold copper sulphate solution and it must be cold, not over 60 deg. F. at anytime, as a hot copper sulphate solution will pickle the steel instead of coating it. It is well to mention here also that the wire itself must be cold before lowering into the copper sulphate solution. For a pure copper sulphate solution the chemical reaction is represented by the following equation.

$$Cu\,SO_4 + Fe = Cu + Fe\,SO_4$$

The copper coating helps to lubricate the wire in drawing and produces a smooth, highly polished finish.

Special Preparation for Lime Coating

If the rods or wire are to be lime coated, this process is just as carefully controlled by having the lime especially prepared in the lime house. The lime should be slacked in a large box and allowed to pass through a screen onto a cement or brick floor. The slacked lime is built up in layers so that the lime should age at least three weeks before it is used. This slack lime is homogeneous, and free from grit, and is added to the tank in the proper proportions so that the lime will be coated on the wire in a fine white film, and not be streaked. It is very essential for good drawing to have the lime uniformly covered over the steel. The lime solution is kept at about boiling temperatures. The lime coating neuteralizes any acid which remains and when dry material-

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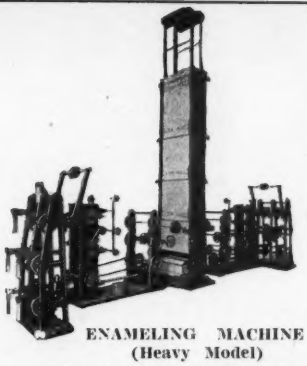

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Famous Wire Drawing Diamond Dies

MAIN PLANT: TREVOUX, FRANCE

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ly aids in the lubrication of the wire while it goes through the dies.

Just before drawing the material must be baked. The object of baking is to drive out any moisture, or gas which may have entered into the porous structure of the steel, and it also tends to eliminate the strain in the metal. The modern bakers are of the continuous type with one door facing the lime vats and the other discharging the buggies near the wire mill. The prime purpose of baking is to thoroughly dry the coating, for if the lime coating is not dry, it will fail to perform its chief function in the wire drawing operation. The bakers are kept at a temperature of from 250 to 400-500 deg. F. according to the class of work and the conditions at hand. Baking is done from 3 to 12 hrs. Another object of the baking is to remove the acid-brittleness which may have developed in pickling. The absorbed hydrogen is driven out by the baking, and the steel is restored to its natural toughness.

Summary of Pickling Situation

A summary of the practical features of wire pickling to be observed are as follows:

1. Obtain the true facts in pickling operations by using temperature recording instruments, and other modern equipment now available to the steel industry.

2. Standardize the pickling practice by simplifying, and reducing the variables in the pickling department to a minimum.

3. Use up to date pickling methods, and pickling department equipment.

4. Classify the materials to be pickled, and standardize on the proper pickling conditions for each material to give first, the highest quality product; and second, the highest production.

5. Use a good inhibitor, properly, to give a nice white finish to reduce acid brittleness to a minimum, and to reduce pickling costs by saving acid, and improving pickling conditions generally.

6. Avoid weak, boiling pickles. They are the main cause of acid brittleness, pitting, and the rough porous finish on the rods or wire, which cuts and destroys the dies.

7. Install plenty of tanks, and have a large pickle tank capacity. This is the basis of good pickling practice, saves tanks and tie-rods from excessive corrosion, reduces the upkeep and repair on the tanks, and reduces pickling conditions of the pickle room, to a minimum.

8. Improve the pickling room conditions generally to conform with the big advancement which has been made in pickling methods, and pickling equipment, within the last few years.

9. Be open-minded to receive new ideas. The art of pickling has advanced.

American Brass Co., Waterbury, Conn., is considering an addition to wire and cable plant at Hastings-on-Hudson, N. Y., to cost over $500,000 with equipment. W. A. Whitaker is local manager.

Ziv Steel & Wire Co., Chicago, has removed its Detroit branch office and warehouse from 2125 Mack Ave., to 14,643 Meyers Rd., where it has completed a two-story office and warehouse building.

B. Greening Wire Co., Queen St., N. Hamilton, Ont., has awarded several contracts and will proceed with erection of an addition on Napier St.

Driver-Harris Co., Middlesex St., Harrison, N. J., manufacturer of wire products, is considering plans for a one-story power house for general factory service, to cost more than $70,000 with equipment. J. A. Finegan, 776 Broad St., Newark, is architect and engineer.

General Electric Co., Boston, Ave., Bridgeport, Conn., has awarded general contract to Pardy Construction Co., 1481 Seaview Ave., Bridgeport, for four-story addition to local plant, 80x200 ft., for production of wires and cables, to cost over $175,000 with equipment.

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Long wear--Smooth-Drawing--Accuracy

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HUDSON WIRE CO.

Successors Royle & Akin

Fine Wire Manufacturers

OSSINING Established 1902 NEW YORK

Influence of Cold Working on Metals

(*Continued from page 125*)

lection of atoms are broken permanently.

But when slip once starts why does it stop; why does it not continue until the atomic bonds are broken completely Jeffries and Archer say[3] that there are two reasons why slip stops. The first is that as slip proceeds the plane builds up a resistance greater than the resistance to the beginning of slip on some new plane. The slip is thus said to be self-stopping. If a ductile metal is stressed in tension, for example, slip starts on a plane of weakness and continues until it is stopped by the resistance of the plane itself. If the stress is maintained slip starts another plane and continues until stopped by the resistance of this plane and so on. The second cause of the stoppage of slip is the end-resistance of the slip plane. The evidence in favor of this idea lies in the fact that failure does not occur by slip along one plane because large single crystals of ductile metals draw out in tension in the form of wedges.

According to Beilby's classic theory, when a ductile metal is deformed by cold work, the crystal fragments slide along each other on these crystalline planes of weakness, and in so doing generate a layer of hard amorphous metal on the slip plane which acts as a cement and prevents further slip. In Beilby's experiments he produced a layer of amorphous metal on the surface of metals by polishing them Beilby's original hypothesis of the formation of this hard amorphous cement is now held as untenable. As Jeffries and Archer pertinently say: "Tungsten wire drawn to 200,000 times its original length without intermediate annealing still gives strong X-ray patterns showing that it is predominantly crystalline.

[3]Jeffries and Archer, The Science of Metal, 1924, page 81.

Hardening of Steel by Cold Work

If we cool slowly a steel containing 0.85 per cent carbon from above the critical range it tends to assume a state of stable equilibrium with the result that at atmosphere temperature the structure consists wholly of pearlite. If we heat this steel again no structural change will take place until the lower critical point is reached, $Ac_{3\cdot2\cdot1}$, but on passing through this point the structure changes from pearlite, the aggregate of ferrite and cementite stable below the range, to austenite, a solid solution of iron carbide in gamma iron stable above the range. Now if we cool this high carbon steel very rapidly the normal change to pearlite is prevented and we have at atmospheric temperature a structure known as martensite. The physical properties are changed radically, the tensile strength has increased from approximately 100,000 pounds per square inch to possibly 300,000 pounds per square inch, and the hardness has increased from about 180 Brinell to 600 Brinell or more. The elongation has decreased from 10% almost to zero.

If we take this high carbon steel containing 0.85% carbon in its stable structural condition of pearlite (or preferably sorbite) and cold work it by drawing through dies we can also increase the tensile strength to approximately 300,000 lbs. per sq. in. and decrease the elongation to practically zero without heating through the critical range and quenching. We have hardened the steel by cold work, and without producing the structure of martensite. The thing which concerns us now is what causes this marked hardening effect with-

out the accompanying structural changes induced by heat treatment. Cold deformation distorts the grain in the direction of work. It is evident that something has happened during this distortion that is responsible for the hardening which results.

One of the first explanations advanced to make clear this hardening is the amorphous cement hypothesis, as was mentioned early in this series. Rosenhain and Ewen advanced the opinion years ago that when a metal or alloy crystallizes from its melt amorphous metal is formed at the grain boundaries where the space was insufficient for the solidifying material to assume the crystal orientation of the adjacent grains. This amorphous metal was hard and vitreous and acted as a cement between the grains. This hypothesis explains why the fracture in a crystalline metal passes through the grains instead of following the grain boundaries. Beilby's hypothesis assumes that this amorphous metal also forms on the slip plane during cold deformation and thus acts as a cement preventing further slip. According to these older hypotheses the hardening from cold work is due principally to the formation of this amorphous metal at the grain boundaries and on the slip planes. But we have just quoted Jeffries and Archer to show that metals cold drawn severely, to the point where they should be almost completely amorphous are still predominately crystalline.

These two authorities sum up their discussion of the amorphous metal hypothesis by stating that there is evidence to justify the assumption that the grain boundary material possesses characteristics of typical vitreous amorphous metals, and plastic deformation below the temperature of recrystallization results in the formation of additional amorphous metal at the boundaries of the original grains. But, they say, the formation of vitreous amorphous metal at all internal surfaces of slip in manner postulated by Beilby is not tenable and the hardness produced by cold work can be readily explained without the assumption of such amorphization. They conclude by saying that the conception of amorphous metal at the grain boundaries furnishes a good explanation of the strength properties of certain metals and is a very good working hypothesis but the importance attached to the specific hardness of amorphous metal as a cause of hardening has been greatly exaggerated.

We may conclude from this that amorphous metal is responsible for some of the hardness and strength evidenced by cold worked metals but is a very minor factor.

Strength of Plane Increases As Slip Continues

If amorphous metal is not responsible for all of the hardness due to cold work the cause must necessarily be found in the slip planes. There is no doubt but that the strength of the plane increases as slip continues until it halts on this plane. Then too, if a metal is cold worked some of the grains are greatly distorted, even ruptured, resulting in the formation of new and smaller grains with somewhat different orientation. This has been proved by X-ray analysis. Slip is thus halted by the interference of adjacent grains.

Thus it becomes evident that the hardening due to cold work is due to slip interference which depends upon several factors. Cold work produces a structure made up of many fine grains; each fragment probably having a slightly different orientation. Slip is thus stopped by the boundaries of these fragments. This is given by Jeffries and Archer as the principal cause of strain hardening. Other factors are resistance to slip of slip plane itself, and additional amorphous metal generated by cold work at the grain boundaries.

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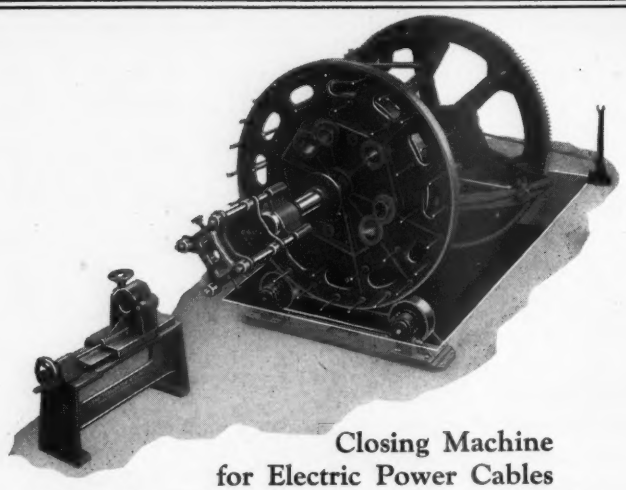

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Twisting plate, closing die, capstan and receive reel take up are included.

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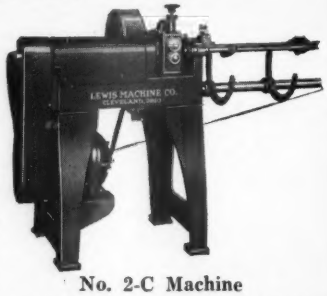

No. 2-C Machine

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There have been other theories advanced to account for the hardness due to cold work. One of these is essentially as follows: When slip occurs amorphous metal is not necessarily formed, but there is a grinding effect which produces crystalline debris on the plane thus halting further slip. Another theory accounts for strain hardening by the production of internal elastic stresses.

Brief Conclusions

We may sum up briefly the causes of strain hardening by saying that it is due to slip interference with the following factors tending to stop the slip: (1) cold work produces many very small grains with an increased number of grain boundaries where slip may be halted. (2) Hard amorphous metal is present at these grain boundaries and there is possibility of additional amorphous metal being generated. (3) As slip proceeds on any one plane the resistance of the plane is increased until slip halts. This is essentially the present theory of the hardening of ductile metals by cold work.

Now, how about steel? The hardening of steel by cold work is due to slip interference with the above three factors entering. But there is also an additional factor that enters when carbon is present, and a very important factor too. This is the obstructing effect of the carbide particles. Pearlite is harder than ferrite due to the increased resistance to slip in the ferrite grains because of the hard

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compound iron carbide; and reasoning along the same line, sorbite is harder than pearlite because of smaller grain size of ferrite and increased dispersion of smaller cementite particles.

Pure iron (ferrite) is harder and stronger when cold drawn than when annealed because of the production of many small ferrite grains and because of the additional amorphous metal formed at the grain boundaries. A cold drawn 0.80 per cent carbon steel is harder and stronger than when annealed because of the presence of many small grains and possibly because of the additional amorphous metal formed at the grain boundaries; and this high carbon steel is harder and stronger when cold drawn than pure iron or low carbon steel—provided of course that they have all received the same amount of cold work—because of the obstruction offered to slip by the many small carbide particles present.

General Cable Corp. has purchased the Peerless Insulated Wire & Cable Co., Pennington, N. J., where Peerless products will be continued under former management as a part of the Standard Underground Cable Division. Sales will continue under the Peerless trade name.

Eisler Electric Corp. has acquired the Tungsten Electric Corp., largest producer of tungsten and molybdenum products for electrical equipment, automobile, aviation and other important industries. Acquisition was effected through exchange of stock and will be operated as a wholly-owned subsidiary.

Associated Alloy Steel Co., Inc., has been incorporated by men associated with the Timken, Sharon Steel Hoop and Ludlum Steel companies. It will market special steel products, including Nirosta, Nitralloy and stainless steels produced by these three concerns. David B. Carson, vice president, treasurer and former sales manager of the Central Alloy Steel Corp., will be the active head, with headquarters in Cleveland.

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Fine wire testing machine to test tensile strength from 500 to 2000 pounds. Box xx, Wire & Wire Products, 551-5th Ave., New York, N. Y.

Mackintosh-Hemphill Co., Twelfth and Etna Sts., Pittsburgh, manufacturer of rolling mill equipment and other heavy machinery, is planning extensions and improvements in branch plant at Midland, Pa., including installation of an electric furnace and other equipment, to cost about $85,000.

Balloffet Diamond Wire Dies, Inc., 342 Madison Ave., N. Y., has leased space in building at 13-15 East Twenty-second St., for expansion.

Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., manufacturer of hydraulic presses, rolling mill machinery, special machinery and parts, has asked bids on general contract for one-story addition, to cost about $40,000 with equipment.

L. A. Young Spring & Wire Corp., reports for the year ended December 31, 1929, net profit of $2,213,026 after charges and Federal taxes. Giving effect to payment of 25 per cent stock dividend of Aug. 15, 1929, earnings applicable to the stock were equivalent to $5.36 a share on 412,500 shares outstanding. This compares with net profit in 1928 of $1,875,664, equal to $4.54 a share on the same number of shares. Net sales last year totaled $15,336,076, comparing with $13,187,040 in 1928, an increase of over 16 per cent.

General Cable Corp., 420 Lexington Ave., New York, has made application to City Commission, Perth Amboy, N. J., for vacating part of DeKalb Ave., adjoining local plant of Standard Underground Cable Co., for addition to rubber-covered wire manufacturing unit, to cost over $100,000 with equipment. Company is developing local works to be largest plant in East.

National Steel Corp. (merged companies) report net profits for 1929 of $12,573,683, equivalent after all charges to $6.07 a share on the 2,072,000 shares of stock outstanding.

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Aetna-Standard Engineering Co., Youngstown, manufacturer of rolling mill machinery, has declared an extra dividend of 50c. per share on its common stock in addition to the usual quarterly payment of 25c., and the regular quarterly disbursement of $1.75 on preferred. The company is operating its two plants, at Warren, Ohio, and Ellwood City, Pa., on day and night shifts, and is completing one of its most successful years.

General Elec. Co. has declared an initial dividend of 40 cents a share on its new stock, placing the issue on a $1.60 annual basis, which is equivalent to $6.40 annually on the old stock, which paid $4 regular with extras prior to the split-up.

American Chain Co. has acquired entire capital and assets of Hazard Wire Rope Co., one of the oldest manufacturers of wire rope in the United States, with a plant at Wilkesbarre, Pa. The purpose of the acquisition was to expand production of three cornered wire rope under the company's patents, controlled by a subsidiary, the American Cable Co. Manufacture of this patented product now constitutes 55% of business of the American Cable Co.

Superior Spring & Mfg. Co., Washington St., Hartford, Conn. manufacturer of steel springs, etc., has asked bids and plans for two-story addition, 60x130 ft., to cost over $50,000 with equipment. G. L. Dunkelberger, 721 Main St., is architect; C. Shultz, 118 Sheffield Ave., New Haven, Conn., is engineer.

Columbia Steel Corp., and subsidiaries, which will be taken over by the United States Steel Corp., reports for the 9 months ended Dec. 30, 1929, net profits of $1,462,776 after interest, depreciation, depletion, Federal taxes and other charges, equivalent after preferred dividend requirements, to 62 cents a share on the 1,499,644 no-par-value common shares.

BUYERS' GUIDE, Continued

DIES—Repairs & Re-Cutting
Balloffet Diamond Wire Dies Co., Inc., N. Y. C.
Bellet Diamond Die Works, N. Y.
Cochaud Wire Die Corp., New York.
F. Krause & Co., Inc., Jersey City, N. J.
Urdika Wire Die Co., N. Y. C.
Vianney Wire Die Wks., N. Y.

DIES—Tungsten Carbide
Master Wire Die Corp., New York, N. Y.
Union Wire Die Corp., New York, N. Y.

DRAWING COMPOUNDS
Oakite Products, Inc., N. Y.

FLUXES—Soldering
Kester Solder Co., Chicago, Ill.

FURNACES—Wire Annealing
Bellis Heat Treating Co., Branford, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

GALVANIZING ENGINEER
W. H. Spowers, Jr., New York, N. Y.

GALVANIZING LADLES, PANS, POTS
Columbiana Boiler Co., Columbiana, O.

GAUGES—Wire
A. Waldeck & Co., Cleveland, Ohio.

LATHES—Die Reaming
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

LIME—Pulverized
Amer. Lime & Stone Co., Bellefonte, Pa.

LUBRICANTS—Wire Drawing
R. H. Miller & Co., Homer, N. Y.
J. T. Robertson Co., Syracuse, N. Y.

MACHINERY—Armoring (Cable, Wire, Hose)
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Braiding
Mossberg Pressed Steel Corp., Attleboro, Mass.

MACHINERY—Bundling
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson.

MACHINERY—Cable
Watson Machine Company, Paterson, N. J.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Cutting
American Insulating Mach'y Co., Phila., Pa.
Eisler Electric Corp., Newark, N. J.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., Cleveland, O.
F. B. Shuster Co., New Haven, Conn.
Sleeper & Hartley, Worcester, Mass.

MACHINERY—Coiling
Broden Const. Co., Cleveland, O.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Chain Making
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Forming
Sleeper & Hartley, Inc., Worcester, Mass.
M. D. Kilmer & Co., Cleveland, Ohio.

MACHINERY—Galvanized Wire
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Insulating
American Insulating Machinery Co., Phila.
New England Butt Co., Providence, R. I.

MACHINERY—Measuring Wire
New England Butt. Co., Providence, R. I.
Watson Machine Company, Paterson, N. J.

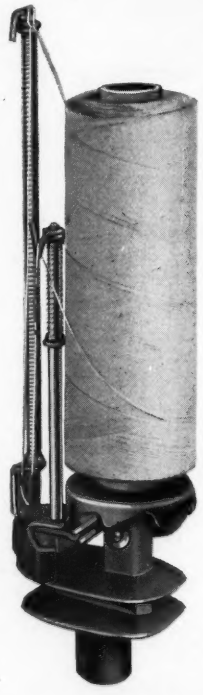
MACHINERY—Nail
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Panning
American Insulating Machinery Co., Phila.

MACHINERY—Magnet Wire Enameling
American Insulating Mach'y Co., Phila., Pa.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Pointing
Torrington Mfg. Co., Torrington, Conn.
Morgan Construction Co., Worcester, Mass.
E. J. Scudder Foundry & Machine Co., Trenton, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
The Waterbury Farrell Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Rivet
The Waterbury Farrell Foundry & Machine Co., Waterbury, Conn.



Patented

Mosspeed Braider Carriers

A Saving of Yarn Assured and a Better Product at a Lower Cost

A patented spring take-up replaces the old-time drop weights. Yarn tension is thus automatically maintained. Bowing and looping are eliminated. The braid is closer and more even, and less yarn is used to cover the wire. With Mosspeed Carriers, the maypole type of braider may be operated up to 75% faster without injury to the machine. With Mosspeeds, your machines may be converted to high-speed braiders at little cost. Ask us for full particulars.

MOSSBERG
PRESSED STEEL CORP.
Attleboro --- Massachusetts --- U. S. A.
Greenville, S. C. Dallas, Texas

Selson Engineering Co., Ltd., 26-28 Charles St., London, E.C.1.

BUYERS' GUIDE, Continued

MACHINERY—Screw Wire
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Spooling
Torrington Mfg. Co., Torrington, Conn.
American Insulating Machinery Co., Phila.
The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Spring Making
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Eisler Electric Corp., Newark, N. J.
Torrington Mfg. Co., Torrington, Conn.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., Cleveland, O.
F. B. Shuster, New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Stranding
American Insulating Mach'y Co., Phila Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Swaging
Sleeper & Hartley, Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrell Foundry Machine Co., Waterbury, Conn.

MACHINERY—Taping
Amer. Insulating Mach. Co., Phila., Pa.
New England Butt. Co., Providence, R. I.
Watson Machine Company, Paterson, N. J.

MACHINERY—Testing
Riehle Bros. Philadelphia, Pa.
Henry L. Scott Co., Providence, R. I.

MACHINERY—Trolley Wire
The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Welding
Eisler Electric Corp., Newark, N. J.

MACHINERY—Winding
American Insulating Mach'y Co., Phila., Pa.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Wire Drawing
American Insulating Machinery Co., Phila.
Broden Const. Co., Cleveland, Ohio.
Morgan Construction Co., Worcester, Mass.
E. J. Scudder Foundry & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
The Torrington Manufacturing Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Wire Rope
New England Butt. Co., Providence, R. I.
Watson Machine Company, Paterson, N. J.

NEUTRALIZING COMPOUNDS
Oakite Products, Inc., N. Y.

PATENTS
Lancaster, Allwine & Rommel, Washington, D. C.

POTS—Annealing
Columbiana Boiler Co., Columbiana, O.

REELS—Annealing
American Pulley Co., Philadelphia, Pa.
Apco-Mossberg Co., Attleboro, Mass.
R. B. Hayward Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

SOAPS—Wire Drawing
R. H. Miller Co., Homer, N. Y.
J. T. Robertson Co., Syracuse, N. Y.

SOLDER
Kester Solder Co., Chicago, Ill.

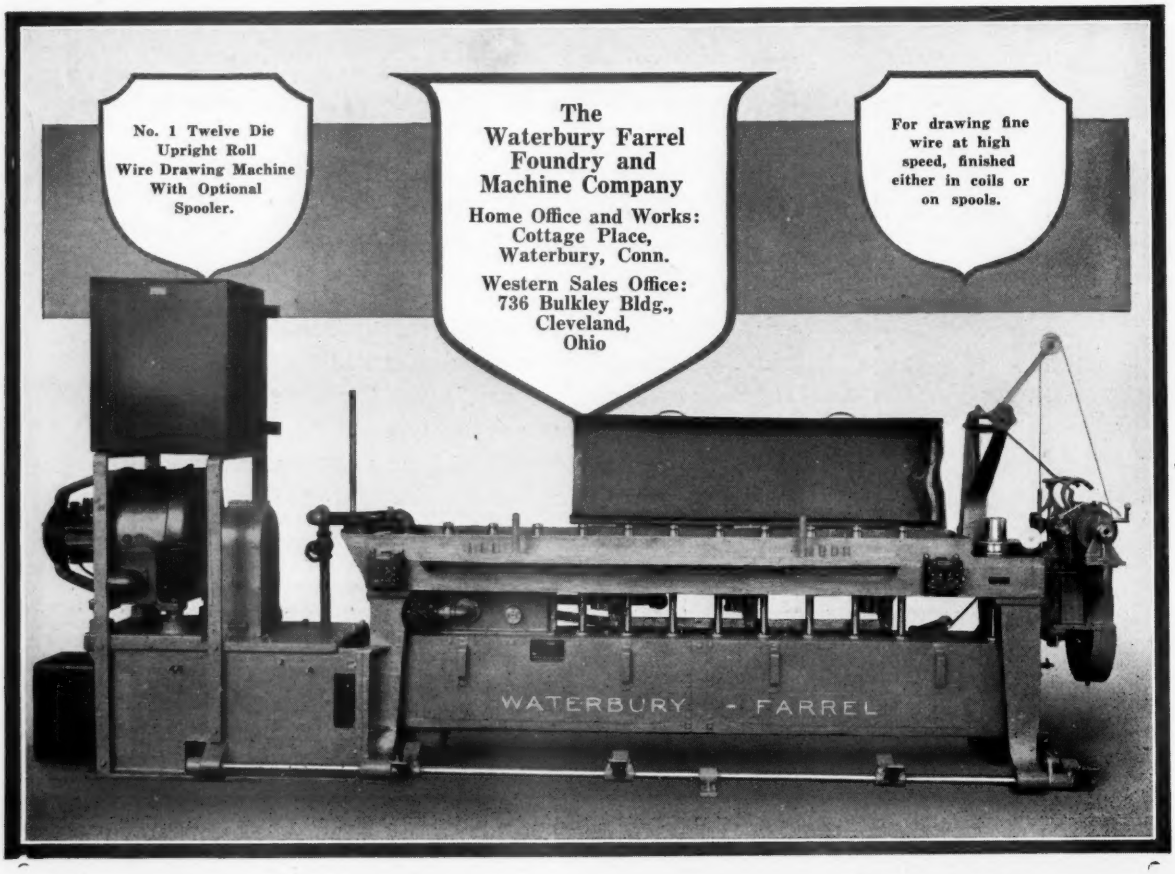
SOLDER—Silver
Handy & Harman, N. Y.

SPOOLS—Wire & Cable
American Pulley Co., Philadelphia, Pa.
Apco-Mossberg Co., Attleboro, Mass.
R. B. Hayward Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

TRUCKS
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

WIRE—Various Kinds
Hudson Wire Co., Ossining, N. Y.
Copperweld Steel Co., Glassport, Pa.

This is a carefully classified index of concerns who specialize in this industry and who advertise regularly in WIRE & WIRE PRODUCTS. Please mention WIRE when writing to these firms.

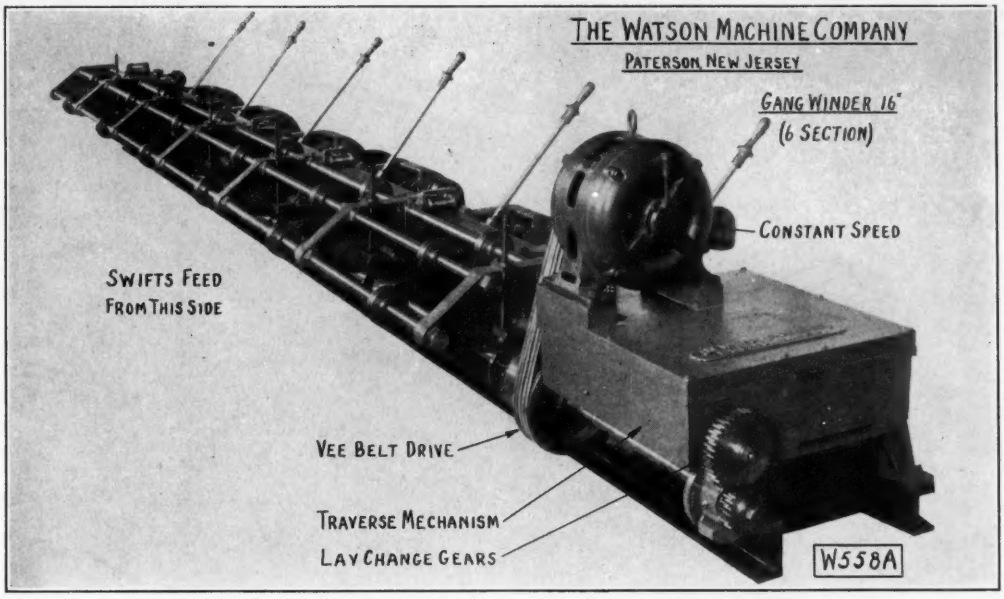

No. 1 Twelve Die Upright Roll Wire Drawing Machine With Optional Spooler.
The Waterbury Farrel Foundry and Machine Company
Home Office and Works: Cottage Place, Waterbury, Conn.
Western Sales Office: 736 Bulkley Bldg., Cleveland, Ohio
For drawing fine wire at high speed, finished either in coils or on spools.
WATERBURY - FARREL

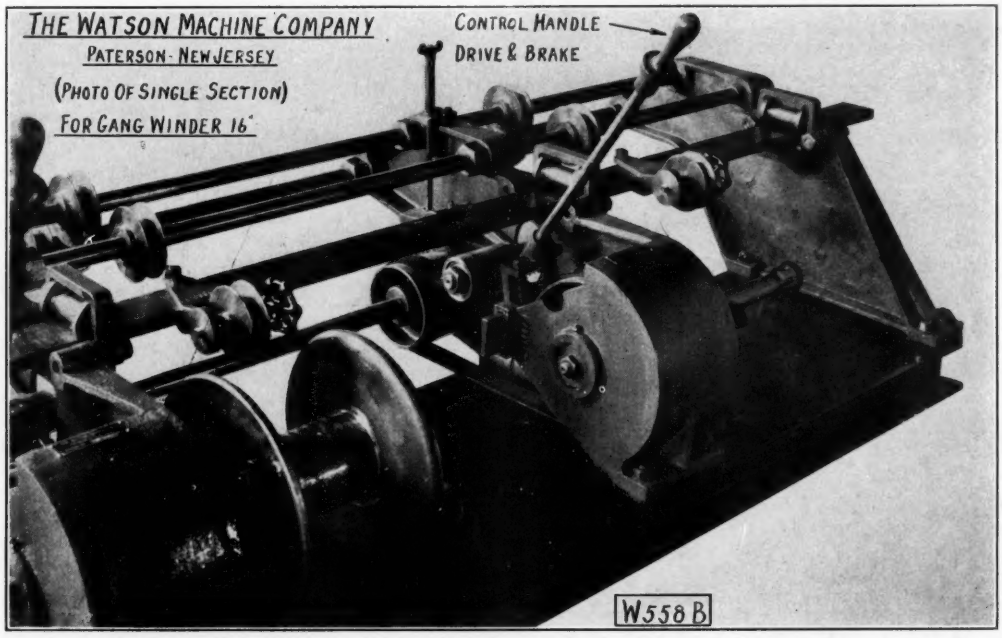
THE WATSON MACHINE COMPANY

ESTABLISHED 1845

PATERSON, NEW JERSEY, U. S. A.

ENGINEERS - FOUNDERS - MACHINISTS





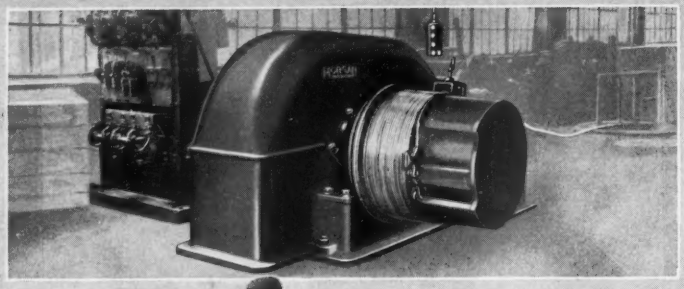
AN ENTIRELY NEW COMPACT GANG WINDER

ELECTRICAL WIRE AND CABLE
WIRE ROPE and CORDAGE MACHINERY

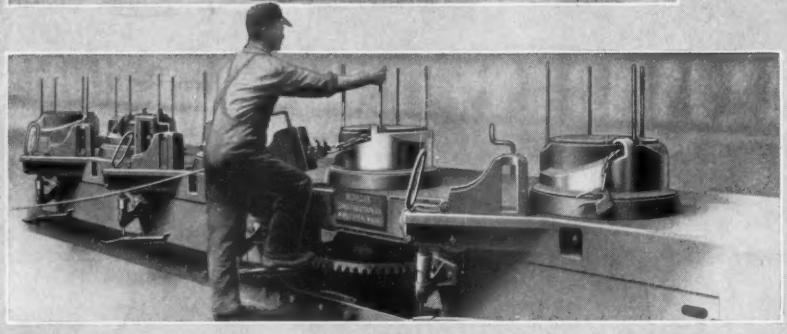
MORGAN CONSTRUCTION COMPANY
WORCESTER, MASS., U. S. A.

European Representatives—International Construction Company
56 Kingsway, London, W. C. 2 Davy Bros., Sheffield, England

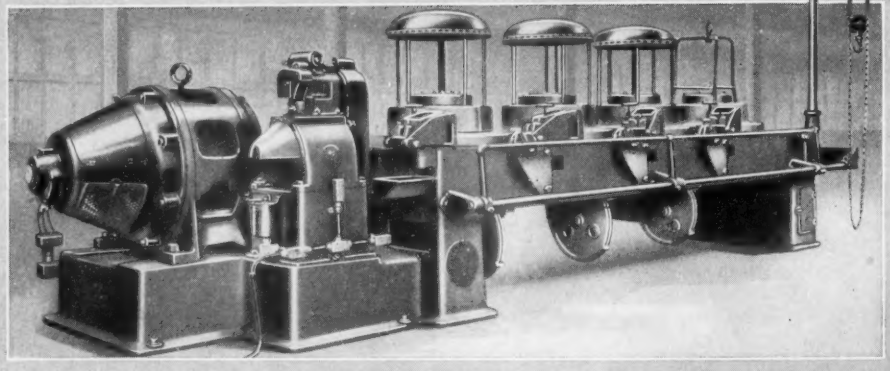
Direct Motor Connected
Bull Blocks
Vertical and



Horizontal



Rod Frames



Continuous Wire Machines

MORGAN
WORCESTER
ENGINEERS AND MANUFACTURERS